Is Bottled Water affordable for the Poorest in Rural Cambodia?

Is Bottled Water affordable for the Poorest in Rural Cambodia?

C. Hutchens*, D. White*, B. Antizar-Ladislao*

*Institute for Infrastructure and Environment, School of Engineering, The University of Edinburgh, The King's Buildings, Edinburgh, EH9 3JL, United Kingdom

Emails: C. Hutchens: s0785565@sms.ed.ac.uk; D. White: s0784746@sms.ed.ac.uk;

B. Antizar-Ladislao: B.Antizar-Ladislao@ed.ac.uk.

Abstract

The rural population of Cambodia suffers from a widespread lack of access to safe drinking water. To combat this, the government of Cambodia seeks to achieve the global Millennium Development targets by halving the number of people without sustainable access to safe drinking water by 2015. Several international Non-Governmental Organisations (NGOs) and private entrepreneurs have already established bottled water programs in rural communities; however the suitability of this service as a low-cost means of supplying the poorest households has not yet been assessed. This paper investigates whether this solution is within the means of the lowest-wealth rural households.

The paper analyses data collected from 240 household surveys, situated in three rural Cambodian communities served by bottled water NGO Teuk Saat 1001 (TS1001). Families were surveyed regarding their income, expenditure on drinking water, and their opinion of how costly the service was. Households that bought bottled water were compared with a control group to establish key financial differences. The survey results were evaluated using an odds ratio analysis, an assessment of weekly expenditure on drinking water, and a comparison of household statements about how expensive they believed their system to be.

The results of the survey suggest that TS1001 bottled water is not reaching the poorest families in the community. Current uptake of the system shows sales trending towards the middle- and high-wealth members of the community, with a high proportion of the lower-income households stating that the bottled water was 'too expensive' in comparison to their existing methods.

Keywords: Bottled water; drinking water supply; Cambodia

Introduction

The rural population of Cambodia suffers from a disproportionately low level of access to safe water in comparison with its neighbours. As of 2008, only 56% of the rural population had access to an improved water source - this still leaves almost 5 million residents vulnerable to poor health from consumption and use of contaminated water. This is very poor in comparison to Thailand (98%), Vietnam (92%) and China (82%) (WHO and UNICEF, 2010). To combat this problem, the National Government of Cambodia has set itself challenging development targets, which fall in line with the international millennium development goals. The government seeks to: (i) by 2015 ensure 50% of the rural population has access to an improved water source; and (ii) by 2025 ensure 100% of the rural population has access to an improved water source.

The capacity for Cambodian communities to provide their own safe water solutions is severely impaired by the nation's financial situation (Irvine *et al*., 2006). Nearly half of the population earn less than $1.25 per day, which is defined as the international poverty line (Ravallion *et al*., 2009). This has resulted in widespread poverty in many rural areas around the country, and the lack of capital prevents villages from maintaining even the current level of service for water and sanitation (UNDP and UNCF, 2007). The situation is made more difficult to solve by the patterns of community distribution across the country. In Cambodia, 82% of the population live in low-density rural areas (ADB, 2007), rendering it prohibitively expensive to overcome the problem by installing large-scale centralised treatment systems.

Bottled water distribution is a relatively new and rapidly expanding sector in the provision of safe water to developing world communities (Hystra, 2011). There are few in-depth studies investigating bottled water in the developing world, and a very limited number have commented on the associated costs to the poor (Friedrich *et al*., 2009; Hystra, 2011). None have specifically considered bottled water provision to the poorest in Cambodia. At present in Cambodia, Teuk Saat 1001 (TS1001) is the largest foreign NGO provider of bottled water. In operation since 2004, the organisation has piloted a unique model for bottled water distribution in rural communities across the West and Central regions of the country. The organisation has rapidly expanded since its inception, and has ambitious plans for future growth. Currently, the Non-Governmental Organisation (NGO) has just over 50 stations in operation; this number is intended to reach 250 within the next six years. By 2018 TS1001 aim to be in a position to provide safe drinking water to over 1 million beneficiaries, while reducing the dependence on foreign donations by becoming financially self-sufficient (Chay, 2012).

The goal of the research was to assess the affordability of TS1001 bottled water for poor households in rural Cambodia. This paper details the methods of data collection and statistical analysis, presents the results of the survey, and discusses them in the context of bottled water as an appropriate provision method for the rural poor.

Method

Ethics Statement

This research study was implemented in rural houses that gave prior consent and with the knowledge that private information would be confidential. It was made clear that the household was in the position to withhold any information they wished.

Sample Group

Stratified random sampling was conducted in three rural communities within the Battambang province, Cambodia. Communities were selected where a TS1001 bottle water distribution station had been running for over one year and was considered financially stable by the NGO. The communities were all situated at least 10km from the city of Battambang, with populations between 1,000-3,000 households. For this study, 240 households were surveyed between 26th December 2011 and 13th January 2012. The sample was divided

equally with a control group consisting of 120 households not using TS1001 and the remaining households currently using the system.

Data Collection

Data was collected for analysis through a survey comprising of formal questions and surveyor observations. A series of questions established data on the household wealth and included: (i) the family daily income; (ii) ownership of transport; (iii) ownership of a television; (iv)supply of mains electricity and (v) access to credit. Observations were also made about: (i) the house type, which was categorised as low, medium and high wealth households: (ii) the quality of road access to the household and (iii) access to toilet facilities. Information on household weekly expenditure on drinking water was also collected and for the control households included the cost for supply and any associated treatment costs including fuel costs, where relevant. TS1001 customer expenditure was based on the number of bottled water deliveries made per week. Opinions of the whole sample group were investigated in relation to bottled water and current treatment methods, and quantitatively assigned to allow analysis.

Data Analysis

Data analysis was carried out in three sub categories: (i) an odds ratio correlation to investigate the uptake of the system given the various wealth factors; (ii) linear regression analysis investigating the weekly expenditure on water given the income of the household and (iii) reasons cited for not buying TS1001. A number of controlling wealth factors were hypothesised and included in the survey as aforementioned. The data was collected and quantified, and the TS1001 and Non-TS1001 groups compared to establish patterns of behaviour. Odds ratios were generated to establish factors that controlled the likelihood of an individual household buying bottled water from TS 1001. An odds ratio of >1 suggested a positive correlation between this factor and participating in the bottled water scheme. Similarly, an odds ratio of <1 suggested a negative correlation. Factors were considered statistically significant if the 95%ile confidence interval was consistently above or below zero. A factor was considered to be positively significant if both the confidence interval values were >1. This was true of the opposite, a factor was considered negatively significant if both confidence interval values were <1. A linear regression plot on average weekly expenditure within each income group investigated the general trend on drinking water spending within the households. The fit of this data was evaluated through the coefficient of determination, variance and the standard deviation. Household opinion on a variety of drinking water aspects was investigated and analysis on the responses was undertaken.

Results

The survey results were evaluated using an odds ratio analysis, a linear regression analysis of weekly expenditure on drinking water and a comparison of household statements about how expensive they believed their system to be.

Direct wealth comparison

A number of controlling wealth factors were hypothesised and included in the survey, and these were compared using an odds ratio analysis. Correlation of the factors that influenced

the uptake, negatively or positively, have been identified with positive correlation indicating that a household is more likely to uptake bottled water. The calculated odds ratios are displayed in

Table 1; results considered statistically significant are shown in bold.

Table 1 Wealth Odds Ratio Analysis

	Teuk Saat User		Control Household		Odds Ratio (95% CI)
	Respondents	%	Respondents	%	
Daily Income ($):					
0 - 2	15	13.04%	31	26.96%	**0.41 (0.21 - 0.80)**
2 - 5	36	31.30%	51	44.35%	**0.57 (0.33 - 0.98)**
5 - 10	29	25.22%	25	21.74%	1.21 (0.66 - 2.24)
10+	35	30.43%	8	6.96%	**5.85 (2.57 - 13.30)**
House Type:					
High Wealth	23	19.17%	19	15.83%	1.26 (0.65 - 2.46)
Medium Wealth	65	54.17%	65	54.17%	1.00 (0.6 - 1.66)
Low Wealth	32	26.67%	36	30.00%	0.85 (0.48 - 1.49)
Road Type:					
Paved	32	26.67%	32	26.67%	1.00 (0.56 - 1.77)
Good Dirt	56	46.67%	38	31.67%	**1.89 (1.12 - 3.19)**
Poor Dirt	25	20.83%	39	32.50%	**0.55 (0.31 - 0.98)**
Path	4	3.33%	11	9.17%	**0.34 (0.11 - 1.11)**
Access to Credit:					
Yes	47	39.17%	51	42.50%	0.87 (0.52 - 1.46)
No	77	64.17%	69	57.50%	1.32 (0.79 - 2.23)
Toilet Facilities:					
Flushing Toilet	77	65.81%	63	52.94%	**1.71 (1.01 - 2.89)**
Latrine Pit	6	5.13%	9	7.56%	0.66 (0.23 - 1.92)
Communal Facilities	7	5.98%	0	0.00%	INF
None	27	23.08%	47	39.50%	**0.46 (0.26 - 0.81)**
Transport Ownership:					
Car	8	6.72%	5	4.17%	1.66 (0.53 - 5.22)
Motobike	88	73.95%	77	64.17%	1.59 (0.91 - 2.76)
Tractor	35	29.41%	37	30.83%	0.93 (0.54 - 1.62)
Bicycle	59	49.58%	79	65.83%	0.51 (0.30 - 0.86)
None	11	9.24%	12	10.00%	0.92 (0.39 - 2.17)
Access to Mains Electricity:					
Yes	87	72.50%	70	58.33%	**1.88 (1.10 - 3.23)**
No	33	27.50%	50	41.67%	0.53 (0.31 - 0.91)
Ownership of Television:					
Yes	100	83.33%	93	78.15%	1.40 (0.73 - 2.67)
No	20	16.67%	26	21.85%	0.72 (0.37 - 1.37)

From the analysis, the following factors were found to be positively associated with TS 1001 use:

- Household daily income >$10
- Access to house via a good dirt track
- Ownership of a flushing toilet
- Access to mains electricity

The following factors were found to be negatively associated with TS 1001 use:

- Household daily income <$5
- Access to house via a poor dirt track or path
- Ownership of no sanitation facilities

Money spent on drinking water

A linear regression analysis of the average weekly spends for each income group shows a trend towards higher costs associated with TS1001, displayed in Figure 1. Lower variance

and standard deviations were apparent for TS1001 customers with the coefficient of deviation being 0.98 compared to 0.65 for the control households.

100% of TS1001 households incur costs for their drinking water compared to only 48% of the control households. This cost comes from collecting water and treating water. Of the control group 67 (56%) boil water with 57 (76%) households having access to a free fuel source. Furthermore 27 (23%) in the control group did not treat their water while 7 (5%) stated that they did not treat water but spent money on water collection. In the control group 52% of households spent $0 on drinking water collection or treatment.

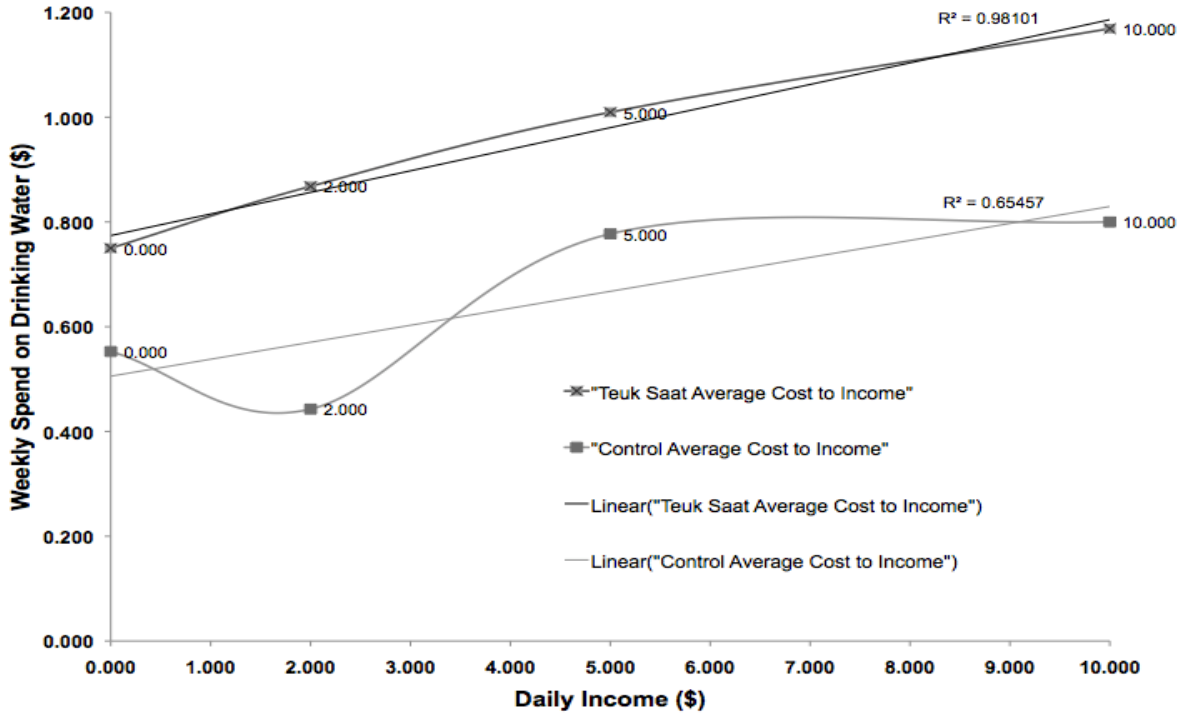

Figure 1 Weekly Cost of Drinking Water Associated with Income

Reasons cited for not buying Teuk Saat 1001

Households were directly questioned as to their financial motivation for choosing to either participate in or disregard the TS 1001 service. Families were initially asked what they liked or disliked about the cost of bottled water delivery, the results are expressed in Figure 2.

A total of 26 households buying from TS 1001 stated that they liked the system because of its 'good price'. Of these respondents, 13 (50%) earned >$5 per day, 10 (38%) earned $2-5, and 3 (12%) earned <$2. When asked, 40 control households stated that they did not buy TS 1001 bottled water because it was 'too expensive'. Of these, 4 (10%) earned >$5 per day, 19 (48%) earned $2-5, and 17 (42%) earned <$2.

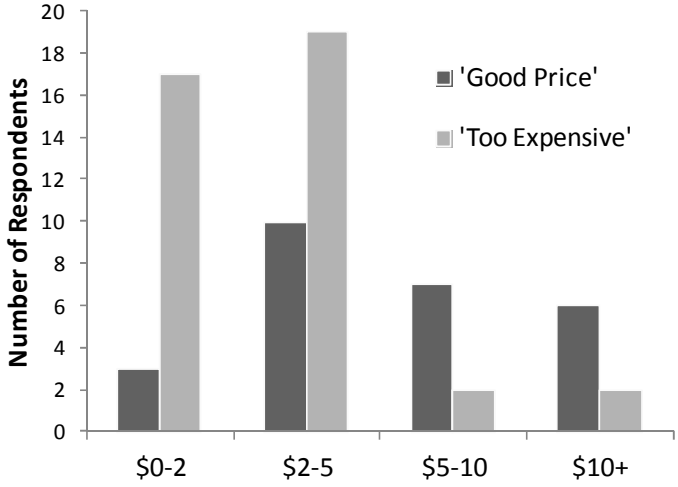

Figure 2 Opinion of TS 1001 Bottled Water

Households were questioned as to their primary motivation for not buying bottled water from TS 1001. The results are shown in Figure 3. Over a third of households surveyed answered 'too expensive'. This was the most common response by a margin of 15%.

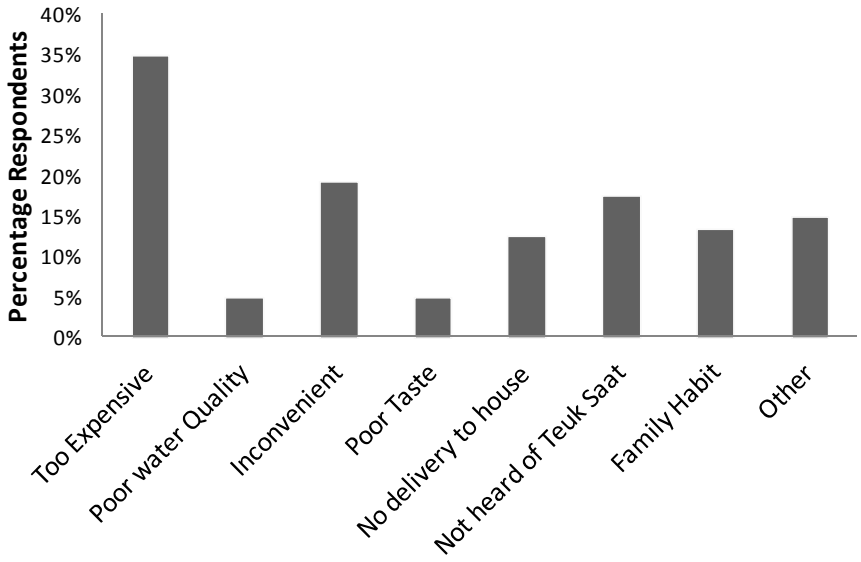

Figure 3 Reason given for not buying from TS 1001

Finally, households were asked if they had previously bought TS 1001 bottled water, but subsequently discontinued the service. Those that had were asked what their primary motivation had been for this decision; results are presented in Figure 4. Of the control households surveyed, 37 (31%) stated that they had previously bought TS 1001 bottles but had subsequently stopped. Of this group, 8 (22%) attributed this to bottled water being 'too expensive'.

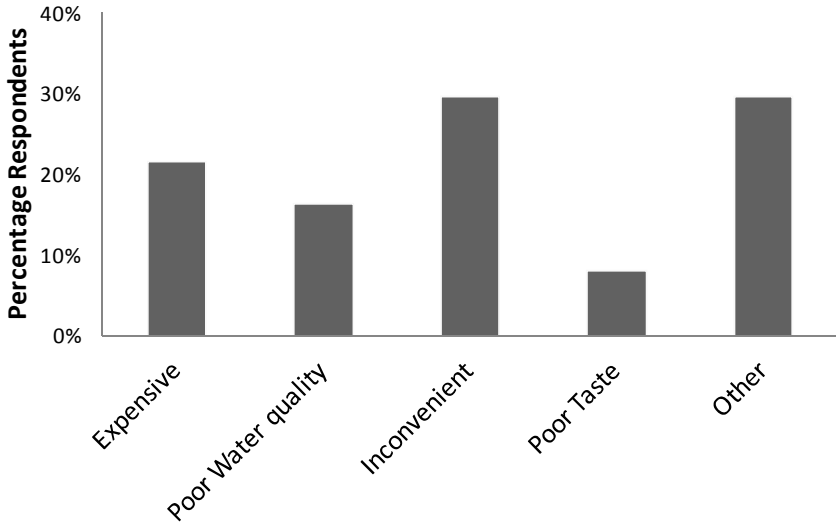

Figure 4 Reason given for not buying TS 1001

Discussion

Based on the odds ratio analysis of the sample groups, it is possible to conclude that families buying bottled water from the NGO are likely to: (i) earn over $10 per day; (ii) have good quality road access; (iii) own a flushing toilet and (iv) have access to mains electricity. In contrast, families are less likely to buy TS 1001 water if they: (i) earn under $5 per day; (ii) have poor quality road access to their home and (iii) own no toilet or sanitation facilities. This wealth divide is made more apparent when taking into account the other factors included in the odds ratio analysis (but deemed statistically insignificant due to the large spread of error). The following factors were all positively linked to purchasing TS 1001 bottled water: (i) living in a high wealth house; (ii) ownership of a car or motorbike; (iii) not having access to loans; and (iv) ownership of a television. Gleick (2004) suggested that the high cost of accessing bottled water may prove a barrier to its widespread application. The results of the odds ratio analysis support this view, despite the comparatively low cost of the TS 1001 service, families that bought bottled water from the NGO were generally wealthier than those that did not. Nearly half of the Cambodian population earn less than $1.25 per day (Irvine *et al.,* 2006), and water quality interventions must be suitably priced to reflect this if they are to be successful. TS 1001 is unlikely to fulfil this criterion, considering that at present the lack of capital prevents villages from maintaining even the current level of service for water and sanitation (UNDP and UNCF, 2007).

This study shows that as income within households increase the amount that is spent per week on average increases (Fig. 1), and this appears to follow an equal pattern between the control and TS1001 households. TS1001 is on average a more expensive option across all income brackets, possibly deterring the increase in expenditure required to access bottled water. What can be noted is that while all TS1001 receive treated water for consumption at point of use, only 77% of control households treat their water and only 48% of the control group have any associated cost for drinking water. This suggests that many households currently have access to free water and may not be willing to pay for drinking water.

In Cambodia it is a traditional and longstanding practice to boil water, PATH (2011) identified that 86% of households regularly boil water. The research in this paper identified that 56% of

households in the control group boiled water and of these 76% incurred no cost for fuels to boil. Additionally 12.5% of those who switched to using TS1001 did so due to high boiling costs, suggesting that the cost for boiling may be influential in determining the uptake of bottled water. It has been previously reported that poor households spend as much as $180 per year on fuel to boil water (Hystra, 2011). Where free fuel is not available it is likely to be expensive, have a high carbon foot print, cause deforestation and involve significant collection time (CDC, 2009; Gilman and Skillicorn, 1985). The provision of safe drinking water is a core amenity of any home; however affluent households have a wider range of goods and services to choose from and are likely to spend more on services offering convenience, social status and perceived quality (PATH, 2011). These findings are reflected in the responses given by households when asked about the cost of their drinking water. Of the 40 families that described TS 1001 water as 'too expensive', 90% earned under $5 per day. This was supported by the fact that over 85% of families describing their own alternative systems as 'a good price' were in this income bracket (Fig. 2). Studies show that 26% of Cambodians rely on rainwater harvesting during the rainy season, as it is essentially free and represents advantages in convenience and water quality (ABD, 2007). Irvine *et al*. (2006) notes that households prefer to drink rainwater above other sources, which may explain the reluctance of low-income households to pay for bottled water delivery.

The Hystra report (2011) concluded that bottled water is most appropriate for medium and high density populations (>2,000 people per community), due to the logistics of transporting the water from the treatment centre. These systems are most cost-effective when treating water that has chemical pollutants or is brackish, as other systems can treat low-pollution water at less expense. In general, Cambodian waters have a relatively low level of pollution (Irvine *et al.,* 2006); although certain aquifers in the Mekong region of the country are known to be contaminated with arsenic (Polya *et al*., 2005). This high quality of both ground and surface water may mean the treatment process is over-prescribed and therefore unnecessarily expensive, although further research is required to investigate this.

A piped water connection has become the standard drinking water source for most households in the developed world, and is the level of supply to which most developing communities aspire (Baker, 2009). Data collected in the Hystra report (2011) shows that having large quantities of safe water available at the tap is the drinking water service that most households covet. While the results of this survey suggest that bottled water has proved a success with middle- and high- wealth families, it has so far been beyond the financial means of many of the poorest households. However, before piped water is widely available in rural homes across Cambodia it may be appropriate as a safe intermediate supply for those that can afford it.

Conclusion

The results of this study indicate that TS 1001 bottled water is not reaching the poorest families in rural communities. Current uptake of the system shows sales trending towards the middle- and high-wealth members of the community, with a high proportion of the lower-income households stating that the bottled water was 'too expensive' in comparison to their existing methods. This was supported by an analysis of typical household expenditure on drinking water.

While bottled water may not be financially appropriate for the most impoverished Cambodian families, it may potentially fulfil the role of an 'intermediate' supply for the more wealthy communities yet to be reached by expensive piped connections. The provision of bottled water to medium- and high-wealth families in the rural areas of the country is likely to have a positive impact on the number of Cambodians with access to safe drinking water. However, this study recommends that NGOs targeting the poorest strata of the community disregard bottled water as a financially appropriate method of distribution.

Acknowledgements

The authors would like to extend their thanks to Chay Lo and Chanrith Kruy (Teuk Saat) for continued support and advice while in Cambodia, Tivy Sovath and Samphos Heng for translating, Paul Byars for advice and mentoring and the Innovation Initiatives Grant at the University of Edinburgh for research funding.

References

ADB, 2007. *Country Paper: Cambodia – Asian Water Development Outlook 2007*. Manila: Asian Development Bank

Baker, J., 2009. *Opportunities and Challenges for Small Scale Private Service Providers in Electricity and Water Supply: Evidence from Bangladesh, Cambodia, Kenya, and the Philippines*. Washington, DC: World Bank

Briscoe, J., 1995. *When the cup is half full: improving water and sanitation services in the developing world.* Journal of the Environment: Science and Policy for Sustainable Development, 35, 7-37

CDC. 2009. *Household Water Treatment Options: Boiling.* Atlanta: Centre for Disease Control and Prevention

Chay, L., 2012. *Interview on Teuk Saat 1001 progress in Cambodia [Interview].* 9th January 2012

Friedrich, E., Pillay, S., Buckley, C., 2009. *Carbon footprint analysis for increasing water supply and sanitation in South Africa: a case study*. Journal of Cleaner Production, 17, 1-12

Gilman, R. and Skillicorn, P., 1985. *Boiling of drinking water: can a fuel-scarce community afford it?* Bulletin of the World Health Organisation, 63, 157–163

Gleick, P., 2004. The Myth and Reality of Bottled Water. In: P. Gleick, ed. 2004. *The world's water 2004–2005: The biennial report on freshwater*. Washington, DC: Island Press (17–43)

Hystra. 2011. *Access to Safe Water for the Base of the Pyramid.* Paris: Hybrid Strategies Consulting

Irvine, K., Murphy, J., Sampson, M., Dany, V., Vermette, S., Tang, T. 2006. *An Overview of Water Quality Issues in Cambodia. In: W., James, K., Irvine, E., McBean, R., Pitt, eds.* Effective Modelling of Urban Water Systems, Monograph 14. Guelph: Computational Hydraulics International

PATH. 2011. *Accelerating Trial and Adoption of POU HWTS among the middle to low income population.* Phnom Penh: Program for Appropriate Technology in Health.

Polya, D. A., et al., 2005, *Arsenic hazard in shallow Cambodian groundwaters*. Mineralogical Magazine, 69, 807-823

Ravallion, M., Chen, S., Sangraula, P., 2009. *Dollar a Day Revisited.* The World Bank Economic Review, 23, 163-184

Tambrekar, D.H., Gulhane, S.R., Jaisingkar, R.S., Wangikar, M.S., Banginwar, Y.S. and Mogarekar, M.R., 2008. *Household Water Management: A systematic study of Bacterial Contamination between Source and Point-Of-Use.* American-Eurasian Journal Agriculture & Environmental Science, 3, 241-246

UNDP and UNCF, 2007. *Improving local service delivery for the MDGs in Asia: Water and Sanitation Sector in Cambodia.* New York: United Nations Development Program

WHO and UNICEF. 2010. *Progress on Sanitation and Drinking Water – 2010 Update*. Geneva & New York: WHO Library Cataloguing-in-Publication Data

WSP. 2007. *Use of Ceramic Water Filters in Cambodia*. Phnom Penh: Water and Sanitation Program Field Note