SUSTAINABILITY OF RAINWATER HARVESTING SYSTEMS IN RURAL CAMBODIA

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ABSTRACT

This paper combines the findings of two studies undertaken by RainWater Cambodia (RWC). The first investigated the sustainability of rainwater harvesting systems (RWHS) in terms of physical condition, ability to maintain and user perceptions in rural Cambodia; and the second study examined community perceptions on RWHS. Findings from these studies will be used to tailor and target rainwater harvesting projects. A key finding of the work was that all major factors affecting sustainability were behavioural, rather than technical. Also, there was no evident correlation between sustainability and socio-economic background. User confidence and ability to maintain the rainwater harvesting system were found to be pertinent in the sustainability of these systems in rural Cambodia.

INTRODUCTION

WASH and behaviour change

Often during sustainable development work, there is a tendency to focus solely on implementing new infrastructure, with little consideration given to monitoring and evaluating past projects. Water, Sanitation and Hygiene (WASH) is no different. This is a consequence of tight budgets and difficulty in justifying expenditure on resources which monitor impact, when there is so much work which is often considered more pressing. This is can be exacerbated by donors wanting to spend money on tangible outcomes such as infrastructure and hardware.

A central component of WASH is access to improved drinking water (a point water source that is adequately protected from contamination, especially faecal matter). Currently only 47% of rural Cambodian households have access to improved water (CECES, 2014). Comparatively, Thailand has achieved close 100% access to improved water, largely using rainwater harvesting systems (RWHS).

Like many forms of sustainable development, WASH requires both infrastructure and behavioural approaches for successful implementation. Evidence from previous WASH projects, in particular hygiene, points to behavioural changes having a greater impact than hard infrastructure projects. However this is not well researched for rainwater harvesting systems. For example, if a customer is not educated in maintenance of a RWHS, the system will inevitably degrade over time. However, if you don't build the RWHS in the first place, there is nothing to maintain. It is therefore important to balance effectively the allocation of precious resources between infrastructure and behavioural change.

Compounding the challenge to balance investment in infrastructure and behavioural change is the influence of subsidies. Since 2003 RainWater Cambodia (RWC) has installed 2,500 residential RWHS but all with large subsidies. Subsidies used in development result in villagers undervaluing infrastructure, which appears to influence the perceived value of the systems by recipients. In RWHS this results in under-repaired systems, with reduced effectiveness in providing safe drinking water as intended. Therefore subsidies are an expensive development practice and alternative funding is recommended.

RainWater Cambodia

RainWater Cambodia was established in October 2003 through a collaboration of Cambodian and foreign nationals. Their common vision was a concern for the health of people in Cambodia, especially women and children. Access to clean drinking water and improved sanitation are clear priorities for improved health and that is why RWC focuses on these areas.

Cambodia is a country with extreme rain variation. Seven months of the year are very wet and five months are almost completely dry. This has resulted in rainwater harvesting being a very traditional practice in Cambodia. However, the water is often stored in unsafe conditions and needs to be supplemented during dry season by either a bore or a water vendor.

Risk managed rainwater harvesting

RWC has designed and implemented improved rainwater-harvesting systems by adopting the WHO drinking water quality guidelines which build on traditional practice and community knowledge.

These systems are designed to capture the large rainfall from roofs and store enough water to last through the dry season. Improved systems have adopted the risk management model to prevent contamination during storage ensuring the water stays safe to drink. The risk management model has critically focused on the design of the rainwater harvesting, storage and distribution.

All RWHS consist of a harvesting system (roof, gutter, first flush system and PVC pipes), storage tank (Jar, 'pieng' is commonly used) and distribution system (PVC piping and taps). Fine screens are located at critical points to prevent animals, mosquitoes, and leaves and dirt entering the tank. There is a cleaning outlet at the bottom of the tank to enable periodic flushing of the tank to clear any debris, which may settle on the tank floor. The first flush system is designed to divert a calculated volume of water from entering the main tank. First flush water is contaminated by a build-up of leaves and dust on the roof and therefore should not be allowed into the tank. This is diverted to a secondary storage that is either manually or automatically emptied.

This study

Primary objectives of this study were to understand the current condition and practices of existing household systems installed by RWC; and to determine the level of functionality and sustainability of those systems. Further, the study sought to identify defects or constraints that have reduced system functionality or sustainabity, and to recommend changes to the processes and/or designs RWC use to install risk managed rainwater harvesting systems.

This study investigated the sustainability of RWHS in terms of physical condition, ability to maintain and user perceptions in rural Cambodia. It is believed to the first study of its kind. Findings from this study will be used to better tailor and target risk managed rainwater harvesting projects in Cambodia.

<u>EXPERIMENT</u>

Data was collected through site visits and conversations with villagers that owned RWHS. Technically skilled staff from RainWater Cambodia conducted interviews with villagers and completed a structural inspection of the RWHS. 40 households were targeted in this survey from four communes in four provinces (10 households from each) in rural Cambodia.

One of two different types of rainwater storage systems had been installed at each household: the jumbo jar or the concrete ring tank. Households were selected to ensure that there was a sample covering all installing years, provinces, and system types. This sample is not and was not intended to be a representative of all RWC work. Respondent households were selected so that findings and recommendations could be made on types of storage, and methods of installation.

Four sustainability categories were identified for the survey. These were:

1. Physical condition assessment including water quality testing
2. Ability to operate and maintain
3. User satisfaction
4. Willingness to sustain the system

The physical condition was assessed by the RainWater Cambodia staff and the ability to operate and maintain, user satisfaction and willingness to sustain the system were all determined by the perceptions of the villagers.

Additionally, community perceptions on RWH practices were also investigated, in particuar the willingness to pay for RWHS and barriers to villagers investing in RWHS. Water quality testing against the National Rural Drinking Water Quality Guidelines was also undertaken.

Following the survey, data was statistically analysed to determine the effectiveness and impact of the RWHS in each of these categories. The analysis involved descriptive statistical analysis such as the use of frequency and percentage, distribution, multiple response, standard deviation, means and computation through Statistical Package of Social Sciences (SPSS).

<u>DISCUSSION AND RESULT ANALYSIS</u>

Key results of the investigation are presented and discussed below.

1. Water Quality

All RWHS failed with respect to E.coli, which has a zero limit for health in the water quality parameters outlined in the National Rural Drinking Water Quality Guidelines. Manganese results were also poor, with only one site within the guidelines. The remainder of the tested sites exceeded the aesthetic limit (although all were below the guideline health limit). Arsenic was not analysed by the RDI-C laboratory and MIME lab in the study. The results for E.coli and Manganese are shown in Figures 1 and 2 respectivly.

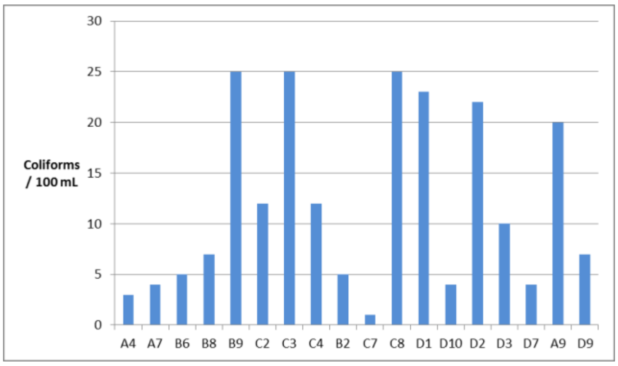

Figure 1: Water Quality Results for E.coli

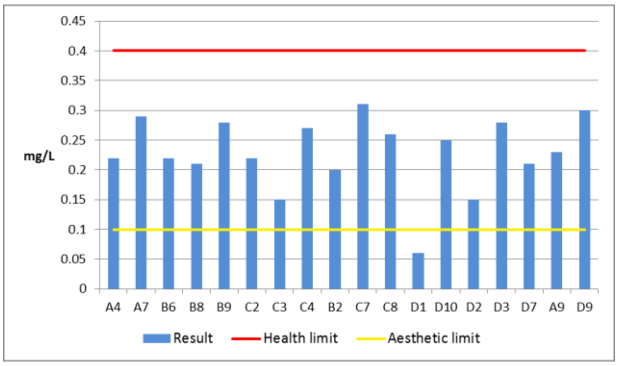

Figure 2: Water Quality Results for Manganese

In terms of user perceptions, 97% of respondents were satisfied with the aesthetic quality of the rainwater and 72% believed the water was safe to drink without treatment.

2. Factors reducing sustainability were behavioural

The survey uncovered that the majority of the factors that reduced the sustainability scores were in fact non-technical. As shown in Figure 3, six of the top seven factors that reduced sustainability scores were not related to the built infrastructure but to the ability of the user to repair and their willingness to use the system.

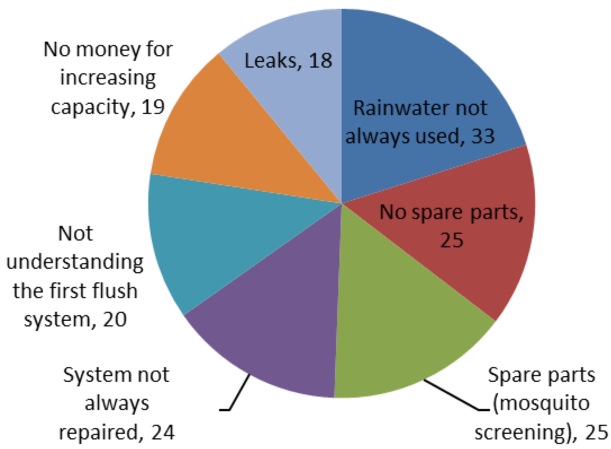

Figure 3: Top Seven Contributing Factors to Reduced Sustainability

The results also identified an extremely high willingness to pay, although this was dependant upon whether villagers were confident that they would be supported post implementation of the RWHS. Technical support in the form of service to repair malfunction or breakage was seen as important.

3. RWHS are still in working order

The survey showed that 90% of the RWHS in the communes were in working order. This was a great result considering the schemes were being installed as early as 2004 and up until 2012. While few of these were in pristine condition this is a good result and means that construction methods are effective.

4. There is no evident correlation between socioeconomic status and sustainability

There is a general perception that higher wealth and education, which is generally linked to age, gender, occupation and family size results in an increased ability to maintain assets and a higher appreciation of those assets. This would result in a higher sustainability of the RWHS. There was no evident correlation between these socioeconomic factors and RWHS sustainability.

However, the results indicate that women may have a greater understanding of water scarcity and quality issues, since they were often using water for various purposes such as cooking, boiling water, washing clothes and cleaning the home. This is a common finding in many WASH and sustainable development research studies.

5. There is a correlation between ability to repair RWHS and sustainability

The only factor where a correlation was observed with sustainability was the user's ability to repair the RWHS. This also had no correlation with socioeconomic indicators. The researchers believe that this can be used as a proxy for the effectiveness of training after RWHS construction.

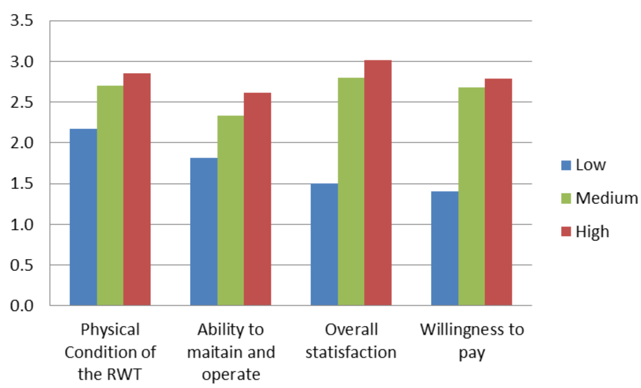

Figure 4: Correlation between ability to do repairs and sustainability scores

6. Leaks are the predominant technical issue

As expected the survey confirmed that leaks were the most common technical issue faced by RWHS. However it was surprising that there were so few instances of foundation failure. Leakages would often be fixed by the villagers but it was very rare, that the fix would stop the leakage fully.

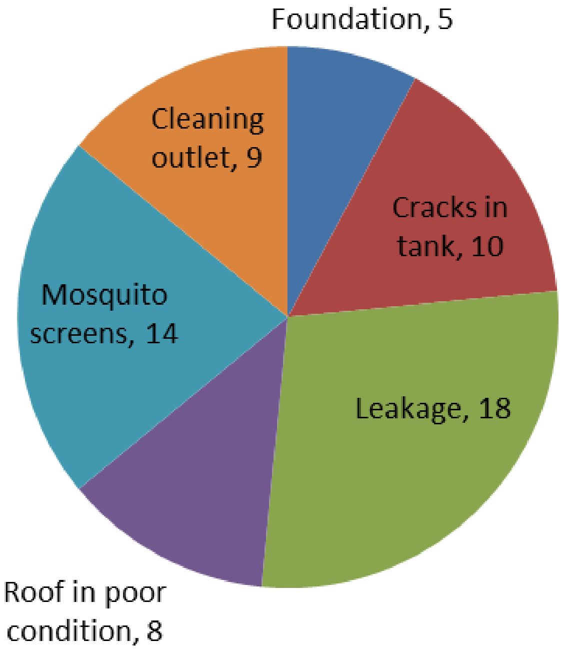

Figure 3: Observed Structural Damage

7. Understanding of the correlation between unclean water and health

While most villagers stated they understood the link between unclean water and health many of them did not believe water to be the cause of their own health problems. The majority of households had experienced diarrhoea in the last six months, but most respondents believed it was caused by food or even the weather. This is despite the harvested rainwater often not being treated and being stored in less than ideal conditions.

RESEARCH APPLICATION

As well as using this to improve the design of their rainwater harvesting systems and operations and training programs RWC wishes to use this study to increase the uptake of risk managed rainwater harvesting systems in rural Cambodia. RWC will run a pilot program with a focus on training to create 100% safe water coverage in one commune in rural Cambodia. This pilot program could then be scaled up and considered as an option for providing water to many homes in the hope of achieving the 2025 100% access to safe water target.

With this goal in mind RWC has concurrently completed another research study investigating the reasons why rural Cambodians collect and store rainwater in the traditional way. By identifying the barriers to risk managed rainwater harvesting RWC has identified several recommendations that would need to be considered in a non-subsidy rainwater harvesting pilot.

RWC determined that many of the barriers to risk managed rainwater harvesting were to do with the support given by local suppliers and commune councils. Any successful program will need to ensure that both commune focal points and local suppliers have their capacity built in a way that they can provide ongoing operations and maintenance support. Further, this study found that increased communication between the villagers would result in each person's knowledge of rainwater harvesting increasing along with their confidence in the RWHS.

Most importantly this concurrent study investigated affordability of RWHS. It determined that there was ability to pay for increases to each household's rainwater harvesting infrastructure. However, not all villagers had the money in one lump sum, so investigations have begun into partnerships with micro-finance.

CONCLUSION

This study is the first of its kind and has uncovered some key factors that impact the sustainability of RWHS. The study has indicated that it is often not the infrastructure itself that is reducing the effectiveness of risk managed RWHS and therefore suggests that more resources would be better spent on education and empowerment. This information will enable more targeted funding for future rainwater projects.

Overall, the RWH systems of Concrete Ring Tanks and Jumbo Jars implemented by RWC were still operating well in all sustainability criteria. These RWH systems had provided positive impacts on household livelihoods including social, economic, and health benefits. The RWHS have provided ease for water supply in the household, reduced expenses on water, and better health outcomes.

Key recommendations arising from this study are:

1. **Physical condition and design considerations**

Increased training on operation and maintenance, in particular, the role of first flush system and its importance in safeguarding water quality. A simplified first flush system model could be the priority as recipients found it difficult to find spare parts.

Extra consideration should be given to installing sufficient storage capacity to satisfy household demands for the whole of dry season. Household size and roof area should be incorporated into storage sizing.

2. Operation and maintenance

RWC will facilitate households to have a clear plan for O&M through participatory approach and improve the training strategy provided to recipients households.

3. Water quality

RWC will integrate household water treatment and safe storage in future training for operation and maintenance.

4. RWC Implementation Strategy

RWC improvement program of its RWHS should be specifically focused on the criteria of sustainability; and should capture the strengths found in the sustainability assessment and improve the systems.

RWC or a trained local provider should conduct follow-up sessions to increase awareness of users on operation and maintenance, hygiene health and especially rainwater management.

Several of the key recommendations above have been incorporated into a proposal for a non-subsidy pilot program. The pilot is proposed to be implemented over 18 months with a focus on education, training and follow up. Training that incudes maintenance and treatment is recommended as part of the proposed pilot program. This would promote greater understanding of the purpose and function of the systems, as well as long term maintenance of the RWHS. The pilot program is proposed to take place in one commune of Kampong Speu, Cambodia. The pilot trial could then be scaled up to meet the 2025 national target of 100% access to improved water.

ACKNOWLEDGEMENTS

The study team would like to thank the villagers and commune representatives that put aside their time for the surveys. RWC and the research team would also like to thank WaterAid Australia for their financial support in completing this research. Lastly, RWC and the research team would like to thank EWB Australia for providing the technical support nessecary to complete this study.

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