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Rainwater harvesting formalization for rural Cambodia

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RainWater Cambodia (RWC) has designed and implemented risk-managed rainwater harvesting systems which are designed to capture the high rainfall in Cambodia and store enough water to last through the dry season. The risk management approach prevents contamination during storage ensuring the water stays safe to drink. These systems are implemented on a household scale, at schools and in remote areas where poor water access can have huge impacts on the level of services provided by RWC team and local entrepreneurs who were trained by the organization. RWC provides RWH systems for households, schools and health centres and since 2004, over 2500 household systems and over 130 institutional systems have been installed throughout Cambodia. Beneficiaries in rural Cambodia well managed all the systems with functionality and capability to supply water for drinking and cooking without the need for other treatment facilities, as it is potable.

Introduction

Within the Cambodian Millennium Development Goals (CMDGs), the Royal Government of Cambodia has clearly outlined targets for 100% of the population having access to safe drinking water by 2025. There is obvious rationale for improving access to safe drinking water for communities, given that it has been declared a "fundamental human right" by the United Nations; however this project undertaken by RainWater Cambodia (RWC) sought to address both the water aspect of the CMDGs.

RainWater Cambodia (RWC) was established in October 2003 through a collaboration of Cambodian and foreign nationals. Their common bond 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. Wherever possible we build on the strengths of traditional practices - such as rain water collection - but do so in a way which manages the risks associated with traditional methods such as preventing mosquitoes from breeding in the tank, preventing contamination from humans and animals and ensuring supply meets the demand during the dry season. Cambodia receives an average of 1,400mm depth of rainfall per year. The annual amount can be as much as 3,000 mm, in particular for the coastal areas. Even though, Cambodia clearly has two seasons, a six-month dry season and a six-month rainy season, however the some rainfall occurs in 'dry season' so there are only two to three months without any rainfall. RWC rainwater harvesting (RWH) systems reflect WHO drinking water guidelines regarding rainwater as an improved water source such as being contained in a covered, protected tank where access is via a tap, and the system contains a first flush system to divert potentially contaminated water from the main tank.

Andrew Shantz's (2011) study of option for safe water access in arsenic-affected areas in Cambodia has recommended that within the effort made for provision of safe drinking water there should be a focus on rainwater harvesting with year-round storage capacity; and possibly also piped water systems. RWC systems also conform to Cambodian Ministry of Rural Development guidelines, which state household storage should be at least 3,000L and in a covered, sealed container. RWC's domestic and institutional rainwater harvesting systems, in rural Cambodia were built by RWC technicians and the local private sector that were trained by the project team on the construction techniques and business model. A quality system has been built by both actors. Quality assurance have been applied during the program implementation; this involved

all local key informants as village, commune councils and sub national government technical department engaged in the implementation process via technical training provided by RWC engineer. The local key informants have adapted the knowledge and key learning for joint implementation of monitoring, supervision and validation of construction by the selected and contracted local private sector contractors. The beneficiaries have been provided with operation and maintenance training and water management advice to ensure longer term positive impact.

This project sought to address some of the global concerns of climate change as relevant to rural Cambodia, through supporting the use of a risk management model which ensures safe drinking water supply without any need for treatment method such as boiling and filtration. To formalize the impact of the rain water harvesting system, a vulnerability reduction assessment (VRA) was conducted both pre- and post-project delivery. Based on the results presented below, RWC believes the positive outcomes from this project demonstrate that the project strategy and simple technology are suited to this application and can be repeated in other locations.

Project delivery method

Assessment and identification of beneficiaries

The access to water situation in the target areas are always conducted with reference to the technical aspects, such as limitations in the number of water infrastructures, quality of supply, quality of water, the distance and timing of access to the water sources etc.. Additionally, the social and environmental aspects have focused on vulnerability of the poor and arsenic-affected areas. The assessment defines the current situation and proposes alternative solution for improving the situation. Importantly, the assessment findings provide information about the real need, amount of water to be consumed and size the storage tank.

Local institution: the first step in improving the water supply in rural Cambodian schools is to assess the schools current water assets and water use of the students and teachers, the condition of the buildings and roof, the number of students and teachers and the schools available water budget or ability to contribute to the rainwater harvesting system. This assessment is then summarized in a report, which is issued to the school and is used as the basis for the infrastructure design. If the roof and school buildings are relatively new then no renovation is required for the roof however sometimes a totally new roof is required for the school.

Householders: In the selection of beneficiaries the main focus has been on the poor households, those with greatest vulnerability and those with very difficult access to drinking water. In Cambodia, data to identify the poor has been established by the Ministry of Planning; and adopted for many development programs, and RWC adapts this for selection of appropriate households to support.

Technical training provides local private sector

RainWater Cambodia's mission statement aims to develop the local private sector in project implementation. The project financially subsidized up to 70% of the total cost for each system for the interested community representatives who invested in rainwater harvesting systems constructed by local entrepreneurs trained by RWC.

Indeed this is an important part of RWC's work contributes greatly to the sustainable development of Cambodia and as such we hold comprehensive training programs for interested entrepreneurs. The training is specific to the infrastructure to be built for that project such as latrines, concrete ring water tanks, hand-washing stations and the different types and sizes of ferro-cement tanks. RWC trainings are designed to cover all the relevant aspects of building WASH infrastructure including theory sessions on the products and materials used - clearly explaining why poor quality cheap materials create low-quality products, and safety considerations. Demonstration products are then built by the RWC technicians before the trainees are encouraged to demonstrate their own abilities. Only when their product is of good quality is the trainee certificated. Further to technical training, entrepreneurs are also given some basic business training, including the benefits of marketing and advertising, efficiency of operations and some basic finance and accounting skills. To further ensure that construction is of good quality, during the project RWC conducts construction validation visits where the construction site is visited at 80% and 100% of completion stages whereupon any subsidies are paid to the contractor only if the work is of acceptable quality. This comprehensive support of the local private sector is to ensure the beneficiaries are provided with good-quality products and to also instill in the entrepreneurs an understanding and appreciation of quality work. It also ensures that if any repair work needs to be done the knowledge is available within the community.

Supporting local authorities on project implementation

RainWater Cambodia is committed to supporting the Royal Government of Cambodia's decentralization and de-concentration process. Commune councils, local authorities, were selected as the focal point and participated in project implementation while they are trained by the project team. Additionally, the support and involvement of provincial, district and communal government in development projects is vital to the sustained development of Cambodia and RainWater Cambodia involves many levels of government in all of its projects. The Provincial Department of Rural Development is especially involved and is vital in providing support and technical advice to RWC during projects. PDRD's staff often support RWC in construction monitoring and supervision as well as during WASH education campaigns and technical trainings.

Technical options and construction

RWC's Rainwater harvesting systems are based on a risk-management approach where physical risks which affect the water quality and safety are identified and mitigated through improved design features of the system. The risk management model has critically focused on the harvesting, storage and distribution components. The system consists of a collection system (roof, gutter, first-flush diversion system and PVC pipes) and a storage and distribution system (tank, PVC piping and taps). Screens are located at critical points to prevent animals, mosquitoes and leaves and dirt entering the tank. A cleaning outlet at the base of the tank enables 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. This is diverted to a secondary tank that is either manually or automatically emptied.. The beneficiaries are trained on the operation and maintenance for all part of the system to reduce the risk of the water becoming contaminated; Also an O&M kit is provided. The diagram highlights the main features of this risk management approach to rainwater harvesting.

Pech Socheat's (2009) study of rainwater harvesting formalization in Kampong Speu showed the quality of water one recipient household, in which the first-flush system as part of risk management model has been removed. The results showed the presence of e-coli and coli form so there was a need of further water treatment options to make the water safe for drinking. Remarkably, at the other 15 households, which had functioning of first-flush systems, the water quality was found to be of good quality and drinkable.. This is the significant finding of the effectiveness of the risk management model when it is properly implemented.

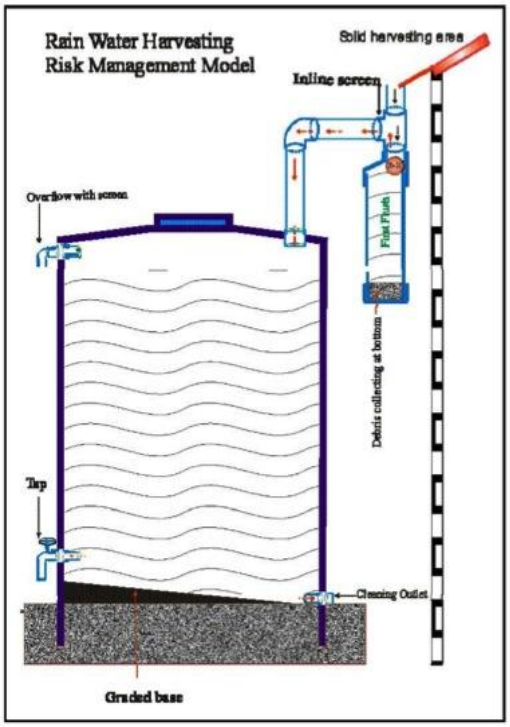

Figure 1. Risk management model

Institutional system

Typically RWC skilled technicians and engineers who have many years of experience are used to construct the large ferro-cement tanks and other products. The cost of these systems ranges from $US 1,700 to $US 4,000, varying with the size and location. The size of the tanks starts from 14,000L up to 35,000L.

Large ferro-cement tanks are technically challenging to construct; quality materials must be used and care must be taken at every step. The failure of a large tank in a place such as a school would be catastrophic. RWC also provides certified technical training to local masons and entrepreneurs who can then construct the tanks. The training is comprehensive and demonstration tanks are built as part of this. Monitoring and validation throughout the construction process ensures that the tanks are of high quality.

Domestic system

Domestic rain water harvesting systems promoted by RWC include two tanks of 3,000L each: as the concrete ring tank and the jumbo jar. It is important to remember that other domestic rainwater harvesting

technologies are available and with different size and technical standards. Moreover, it should be emphasized that the tank is just one part of a complete domestic rainwater harvesting system and that each part plays a very important role. Within this specification of the system, the cost ranges from $US 160 for jumbo jar and $US 250 for concrete ring tank.

Figure 2. Concrete ring tank

This is the main type of tank that RWC installs notably due to the ease of construction and the high number of concrete rings makers at local level. A typical household installation has two tanks, that together hold 3,000L of water.

Figure 3. Jumbo Jar

Jumbo jar is the traditional shape and lower cost of these 3,000L tanks. Their traditional shape makes them very popular, even though they are less flexible and more complex to construct than concrete ring tank.

Operation and maintenance training

An important part of any RWH project in schools, health centres and households is the Operation and Maintenance training. This is a vital step in ensuring the sustainability of the system. Typically an introduction to the different parts is given including demonstrations of how each part works (i.e. emptying the first-flush system, turning the valves on and off, how to clear the screens, how to clean and flush the tank and the importance of keeping the gutter free from leaves). The school is also provided with a number of spare parts and instructions on how to repair parts of the system. Accompanying the training is a clear easy-to-follow manual which can be kept at the school and posters highlighting the system which can be displayed in staff rooms. The manual contains contact numbers of RainWater Cambodia and if a local mason is available, his contact details are also provided.

Project results

RWC has received positive feedback from all project stakeholders in regards to the project approach and the achieved outputs and is well-recognised in Cambodia as a very good in rain water harvesting programme. This project has delivered a safe drinking water supply to 15 provinces and to the capital in Cambodia. The following table presents the number of rain water harvesting system formalized in Cambodia since 2004 as:

Table 1. Number of rainwater harvesting system build in rural Cambodia

Items	Domestic System	Institutional Systems	Beneficiaries
Household	2,502		13,761
School		113	39,550
Health Clinic		19	11,400
TOTAL	**2,502**	**132**	**64,711**

Health benefit

Besides the number of water facilities built throughout rural Cambodia, the main outcomes of the program have been positive impact on health, social and environmental aspect. Peter McInnis's (2008), study of the pilot rainwater harvesting program in Cambodia showed that rainwater was considered to be of very high quality by both recipients and non-recipients and was thus used extensively. Both categories of participants still collected large quantities of water and although the majority of recipient households still had water remaining in their tanks, several had used it all up for non-essential purposes. Additionally, the pilot study revealed positive impacts on health and improvements in the livelihood of recipients of the RWC program.

Environmental benefit

This project has demonstrated the appropriateness of zero energy use for a water treatment before drinking. The households with rainwater harvesting system built have spent reduced time collecting water from the community pond, and do not need to spend money on fuel to boil their drinking water; there is health benefit from the provision of easy access to this safe drinking water. RWC also implemented community-based climate change adaptation in which the rain water harvesting system is one of the significant innovation vulnerable households and community to use to reduce their vulnerability. Vulnerability reduction assessment (VRA) have been carried out before the start and after completion of projects to measure the level of project success, in particular in relation to the risk of drought from climate change. The pre= and post-project VRA results are compared in Table 2, which shows a significant reduction in their vulnerability to further climate change impact.

Table 2. Climate Change Impact

UNDP Vulnerability Reduction Assessment (VRA)	Before	After	Reasons For Change
Future Climate Change Impact	4.62	3.27	Clean drinking water system installed utilising solar pumping and rain water harvesting formalization
Note: 1 low risk, 2: Under moderate, 3 moderate, 4 high, and 5 highest			

Social benefit

This project has significantly supported the decentralized local authorities through the establishment of operation and management committees and implementation of training on social accountability and demand for good governance. Project sustainability has been a critical focus for RWC within this project. The knowledge and resources have been mobilized and absorbed by the local community as local private sector, masons and labour now have enough capacity for the construction of rain water harvesting systems; and are being selected as counterpart in construction by other donors and partners in Cambodia.

The project has strongly reinforced the capacity of its partners, such as government technical departments, local authorities and the private sector in regards to relevant design and construction processes for the implemented technologies. RWC have also presented the project outcomes and lessons learnt at the national level WATSAN meeting, which is chaired by the Ministry of Rural Development. Attendees at both of these knowledge-sharing events expressed their enthusiasm to incorporate the lessons learnt from this project into their own future projects. A summary of these lessons learnt is presented below.

Key factors for project success

Listed below is a summary of the key factors, which resulted in the success of this project and as such comprises the list of recommendations for others, implementing similar projects in the future?

- Technical assistant from Engineers Without Borders Australia.
- Strong support by WATSAN sub-group which is chaired by the Ministry of Rural Development and includes many WASH Active NGOs in Cambodia.
- All the program approaches have contributed to the government's MDGs toward improving access to safe water.
- Rain water is the common water source used by Cambodian people.
- The use of reliable, good quality subcontractors is worth the extra cost; they are well-trained by the project team.

- Clear definition of the scope of work for each subcontractor eliminates confusion and delays during construction.
- RWC has extensive experience and has supplies and skilled technician who are able to design, prototype and build system for water supply. In addition they can do the same for sanitation and hygiene facilities.

Conclusion

Rainwater harvesting formalization is feasible and widely adapted through the community, as many Cambodian people prefer rainwater as their main source for drinking and cooking. However, the commonly-used collection method is in need of a risk management analysis. Contamination and shortage of water often occur. RWC has introduced the new risk management model as presented in the above section to mitigate all the risks. RWC's rainwater harvesting system are fairly easy to construct. The local people can built the concrete jar following a similar method to that used for the traditional 'Peang jar'. The concrete ring tank's construction is not very complicated. In addition to the construction of the tank the users need to follow the risk management model and incorporate some additional water quality improvement features as presented in this paper.

Some studies found that rain water harvesting program contributed in health and family livelihood improvement. Additionally, this technical option is appropriate for the areas of Cambodia where access to alternative water source is challenging. From a rainwater harvesting business perspective, the RWC model is not yet commercially viable because it requires subsidy from the donors and the government. Moreover, the philosophy of the system is to only supply water for drinking and cooking. RWC is investigating product development to enlarge the capacity of storage so rainwater can be used for all domestic uses.

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