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Success and Success Factors of Domestic Rainwater Harvesting Projects in the Caribbean

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Abstract

In the Caribbean, domestic rainwater harvesting (DRWH) projects are being implemented to augment water supplies in water scarce islands and as a no-regret approach to adaptation to climate change. The evaluation of these projects is usually limited to the implementation process i.e. measuring the ability of the project to meet the set deliverables. Factors that are considered are the cost and time specified for the installation of the DRWH systems and the quality of the harvested water. There is seldom a post-project evaluation to determine whether the beneficiaries are able to properly maintain the system and or to improve on it, or whether the project is leading to increased household collection and use of rainwater in the project location and its environs. This paper is based on a survey of key stakeholders actively involved in the promotion of DRWH over a number of years. Active involvement was the basis of accepting the information on their perception as adequate in providing a reliable measure of the level of success of DRWH projects. The metrics for success were based on stakeholders' perspective of the success of DRWH projects as determined by community involvement, rate of uptake of DRWH, increased awareness, impact of training on maintenance of systems, appropriate use of the systems, increased use of rainwater, increased capacity of community leaders to train and improved support by local private sector. It was found that there was willingness to invest in DRWH particularly among the stakeholders who have regularly used rainwater. The stakeholders were also asked to corroborate a set of pre-selected factors that were considered important for the successful development of DRWH projects. A ranking of these factors indicated that although the cost of the DRWH systems was the most important factor for success, technical issues were imperceptibly more important than economic and social issues.

Keywords: success factors, domestic rainwater harvesting, Caribbean

1. Background

"Nothing is more useful than water: but it will purchase scarcely anything; scarcely anything can be had in exchange for it" (Smith, 1776). In 1992, the Dublin Statement of the International Conference on Water and the Environment recognised that water should be considered an economic good, giving credence to Smith's statement. Today, dwindling freshwater resources threatens the availability of conventional water supplies in several parts of the world and as such, greater emphasis is being placed on harnessing alternative sources. Rainwater harvesting (RWH) is a broad term for small-scale, collection, storage and use of rainfall runoff for productive purposes. In this context, RWH is a simple low-cost technique that requires minimum specific expertise or knowledge. Through the ages, RWH, has been an important source of fresh water for agriculture and domestic use.

Harvested rainwater is used for both domestic and commercial purposes. Domestic rainwater harvesting (DRWH), that is, collecting rainwater from roofs and storing it in containers of varying sizes for household uses. Traditionally this has been the main source of potable water, particularly in remote and isolated communities. Recently, DRWH has been given a new lease on life after expansion of conventional public water supply systems was found to be unable to satisfy the demand in all situations. The impact of climate change through the increased and prolonged drought conditions and variations in rainfall patterns have been the driver for growing interest in RWH. As a result, DRWH is finding application in drought mitigation, flood mitigation, poverty reduction, crop irrigation, watershed protection and carbon emission reduction (Ariyananda, 2009). In the Caribbean, the practice of RWH is contributing to resilience in water management. The importance of RWH in

sustainable development and in the adaptation to climate change as a no-regret option, has been highlighted (Pandey, *et al.*, 2003). An example is in the case of Grenada where after Hurricane Ivan, a DRWH project was commissioned to build resilience in water communities in terms of access of water in a post-disaster environment and to augment supplies during droughts (CEHI, 2006).

Recognising the potential of DRWH, many regional and international agencies are responding to climate-driven water resource challenges by promoting RWH (Global Water Partnership-Caribbean 2016). In the Caribbean, DRWH projects are being implemented to supplement water supplies in water scarce islands. In many cases, considerable resources are utilized in DRWH projects to enhance potable water supply (GWP-C, 2012) and for commercial application in the tourism industry and agriculture sector (Blake, 2014).

Due to the project approach adopted by developers of DRWH projects, their evaluation usually limited to the construction phase (Bhuiya 2013) and hence focuses on the ability of the project during the construction phase to meet a set of objectives related to time and quantity. In other cases projects are evaluated in terms of water savings (Abdulla and Al-Shareef, 2009; Eroksuz and Rahman, 2010). In the case, of DRWH projects, after the system installation, there is seldom a post-installation evaluation to determine the sustainability of the system. For example, there is no assessment of the beneficiaries' ability to properly maintain the system or to improve on it, or whether the project is leading to greater utilisation of harvested rainwater in the community. Needless, to say, the RWH infrastructure should be built to function efficiently over time, i.e., to provide adequate water to meet the needs of the users in a sustainable way, particularly in relation to climate change.

Although governments, non-government organisations (NGOs) and international development organizations are actively promoting RWH in the Caribbean, there have not been any empirical and coordinated studies to measure the success of such projects by evaluating the efficiency and effectiveness of this technology as an alternative and/or a primary water source. Factors for better policy development, if identified and considered during project design and implementation, can enhance DRWH promotion. CEHI (2006) proposed a programme for promoting RWH in the Caribbean region which recommended that there should be a coordination of monitoring of the success of national DRWH programmes.

In this research, success of DRWH is interpreted as the extent by which RWH technology is adopted for meeting drinking water needs. This paper therefore, evaluates the factors contributing to the success of RWH projects as perceived by principal stakeholders (managers in the international aid agencies and regional agencies, local officials, project team, steering committee members, beneficiaries). It analyses the opinions of these principal stakeholders which were solicited on the following issues: how correctly was the RWH systems installed; how well did water harvested from the systems meet expected quantity and quality; what was the level of consumption of the harvested water; how well were the systems maintained; how adequate was the technical and financial support; and what was the adaptation response as a result of the projects. Further, the opinions were solicited in determining the factors that influence the success of RWH, particularly, with regard to the up-scaling and sustainability of DRWH projects in the Eastern Caribbean. Factors such as the knowledge, attitudes and practices of DRWH, and how favourable are the local cultures, the institutional environments and governance of DRWH are considered.

2. Literature Review

There has been a revival of RWH around the world due to a number of factors (Smet, 2003). These include the failure of centralised water systems due to decreased quality and quantity of the source, safer roof material, lower costs of storage tanks and greater emphasis on community-based approaches and technologies which emphasise participation, ownership and sustainability of water supply (Smet, 2003). The revival is also driven by a number of reported success stories on RWH projects for domestic and commercial uses. For example, in Chennai, India, Krishnan (2003) observed that households were willing to invest in RWH after hearing of other people's experiences. The success of a 2009 RWH project by NetWater and its partners that installed RWH systems at 12 hospitals in Sri Lanka triggered a further 22 RWH applications by 2011 (Women for Water Partnership, 2012). In Central Sudan, Ibrahim (2009) reported on how the success of small RWH dams has encouraged the authorities to expand the RWH initiative as part of a long-term solution for the water supply in the city.

In the Caribbean, the practice DRWH is evolving and expanding (Dempewolf *et al*., 2015). Generally, DRWH projects fall under a broad heading of not-for-profit developmental projects. As with other developmental projects, the criteria to objectively assess the success of DRWH is project specific. Although, many methodologies developed to assess the sustainability of RWH projects recognise the importance of the socio-economic factors for success (Goyal and Bhushan, 2005), these factors are often not incorporated in the

assessment. This non-integration of socio-economic factors was identified as the main cause of failure of RWH projects (Kahindaa *et al.,* 2008). In a study of two RWH projects commissioned by UNICEF (2004), it was found that RWH projects were successful where there was a willingness of beneficiaries to contribute in terms of both labour and funding. The study also suggested that success could be hampered by the involvement of multiple agencies resulting in uncoordinated execution which leads to an increase in overhead expenses.

Typically, the success of RWH projects is measured by some specific objectives like water availability, improvement in household water supply and sanitation (Kahinda *et al*., 2006) as well as greater household productivity that results in the saving of time and energy (RAIN, 2014). Success of RWH projects should also be measured by levels of adaptation as indicated by increased participation in RWH, growth in the number of systems and improvement in operations of established systems over time. Previous evaluations of RWH systems, however, focused only on quality and quantity issues (Despins *et al*., 2009; Toronto and Region Conservation Authority, 2010), and economic viability (Roebuck *et al*., 2011). Therefore, the tendency is to measure the success of DRWH projects by how much of the expected outputs, based on the project design, has been realised over the short-term, that is, during the implementation period of the project

The success of DRWH projects is, of course, not guaranteed in all situations. For example, while domestic rainwater harvesting systems (DRWHS) are being widely promoted as a solution for the growing drinking water crisis in many underdeveloped and developing countries, there are limitations to the use of DRWH. On the other hand, Kumar (2004) argued that RWH systems are not alternatives to public systems in urban and rural areas of regions that receive low rainfall, particularly for urban housing stocks of low and middle-income groups.

Another factor that can influence success is legislation. The literature shows that legislation that enforces rainwater harvesting for new buildings is being introduced in many parts of the world (Rainwater Harvesting, 2002; Rainwater Harvesting, 2010; Government of Jamaica, 2013). However, legislation must be supported by effective institutional and organizational arrangements. In Delhi, despite the legislative requirement for RWH several factors have contributed to failure (Dikshit, 2012). These include inadequate financial assistance, bureaucracy and poor maintenance of structures once they are built (Dikshit, 2012). In another Indian district, the majority of the RWH projects that were set up at various government institutions became defunct after 5 years owing to lack of proper maintenance work as a result of institutional and organizational failures (Kannan, 2014). In the case of the Caribbean, Hutchinson (2010) reported that in Barbados, regulation had a positive effect on the storage and use of rain water for secondary purposes. While success may not be achieved through the passing of legislation (Karnna, 2014), legislation may be necessary but not sufficient as the accompanying innovative policy interventions, incentives and regulations by local urban bodies must be adopted (Kahinda and Taigbenu, 2011).

A high degree of stakeholder participation is necessary to guarantee the acceptance of proposed projects. For many development projects, experience has shown that beneficiaries are often not satisfied with the programmes when these do not meet their expectations (Zimmermann *et al*., 2012). For example, poor stakeholder participation can cause projects to fail when beneficiaries decide to use the RWH tanks as storage facilities for conventional public water supply rather than for storing rainwater. This could be a case of inertial resulting in an unwillingness to adapt to the DRWHS. However, when such projects are intended for RWH, this is usually an indicator of poor beneficiary targeting and the non-participatory approach adopted in the implementation phase (Ariyananda and Aheeyer, 2011). In this context, Boodram *et al.* (2014) identified targeting and engaging communities, establishing partnerships with private sector organisation, expansion of training to include certification and entrepreneurship training and monitoring of projects as necessary for improving the success in RWH.

Understanding the critical success factors enhances the ability of funders of RWH projects to ensure desired outcomes. However, defining the criteria to measure project success has been recognized as a difficult and controversial task (Baccarini, 1999; Liu and Walker, 1998). Research on success factors for industrial, commercial and general projects is widely available but, research on not-for-profit development projects like RWH is limited. Such projects with humanitarian and social objectives are usually much less tangible, less visible and not easily measurable, compared with projects commonly found in the private sector (Khang and Lin Moe, 2008). Diallo and Thuillier (2004) undertook an important empirical research that focused on the specific success criteria and factors of development projects. They did so by assessing the project success as perceived by the key stakeholders. They found that management dimensions (time, cost, quality) were of high importance while project impacts were rated lowly. Generally, the factors selected for inclusion in evaluating success of projects can vary considerably (Fortune and White, 2006).

In the Caribbean, successful rainwater harvesting projects are generally associated with communities that consider adequate water supply a priority (UNEP, 1997). Consequently, recent DRWH projects in the Caribbean aim to promote and expand the application of RWH such that there is higher rate uptake of the technology (CEHI 2006; GWP-C 2016). Yet there has not been any formal mechanism that evaluated the potential or actual up-scaling of RWH projects (increasing catchment areas, storage capacity, improving quality by installing purification facilities) or increasing investments and sustainability (maintenance of quantity and quality over time). This is partly due to the requirement of long time for monitoring these indicators and the complexities involved. In 2006, participants at a regional workshop (Promoting Rainwater Harvesting in the Caribbean) proposed that the success of RWH projects in the region should be monitored (CEHI, 2006). Boodram and Dempewolf (2015) recognised that while evaluations of Caribbean Integrated Water Resources Management (IWRM) initiatives including RWH, are routinely carried out immediately after project completion, assessments are lacking on the long term viability and sustainability of the initiative. Follow-up is lacking and the long term effects of the project remain unassessed, therefore limiting the ability to replicate projects to be more successful andt effective in the long-term (Boodram and Dempewolf, 2015).

3. Methodology

An evaluation of DRWH projects can be carried out by soliciting the views of key stakeholders who have been or are actively involved in DRWH projects. In this study, the stakeholders were mainly experts in RWH who were identified as suitable for participation in the survey since it required much less resources than that for surveying beneficiaries spread over many islands. Moreover, access to the experts was easier than other beneficiaries. For this study, experts are defined as persons who are or have been actively involved in the development of DRWH through project design, project implementation, training and capacity building, technical support to projects in post construction phase, project monitoring, research, project financing and the promotion in communities. Participants for the research were selected from sources. Firstly, use was made of a data base of Caribbean experts in water and related fields created by Global Water Partnership-Caribbean (Global Water Partnership-Caribbean, 2014). Secondly, the annual conference of the Caribbean Water and Waste Association, the biggest gathering of professionals in water management in the region was used to identify and solicit participation in the survey. Finally, a list experts was supplemented by identifying additional suitable candidates for participation through consultation with regional and international NGOs involved in RWH activities, government departments responsible for water issues and water utility companies in the islands.

A total of 45 persons were identified as experts in RWH meeting the criteria of active involvement in DRWH. Of these, 40 persons, who could have been contacted, were invited to participate in the survey. Participants were selected from among 5 groups namely: government, non-governmental organisations, technical support, water utility companies and researcher.

A pilot survey was administered to three experts to pre-test the questionnaire in order to eliminate inadequacies or ambiguity in the questionnaire. The participants were invited to comment on the format of the questionnaire and make suggestions which were considered for incorporation into the final questionnaire..

The first section of the questionnaire was comprised of seven items to obtain information on the level of involvement of the participants in DRWH. The second section comprised 42 questions that sought the participants' perspective on performance factors that would determine the success of DRWH projects in the Caribbean. Each question in the second section was based on a 7 point Likert scale where 1 = strongly disagree and 7= strongly agreed. There were 4 questions related to community involvement; 6 questions related to training; 9 questions on success; 7 questions on the beneficiaries and users and 16 questions specific to the development and sustainability of RWH projects. The questions on success measured: community involvement, rate uptake of DRWH, increased awareness, impact of training on maintenance of systems, appropriate use of the systems, increased use of rainwater, increase capacity of community leaders to train and improved support by local private sector.

In the third section participants were asked, to use a scale of one to ten, to rate the importance of 14 success factors where one represented low importance and ten was very high importance. The list of success factors was compiled from available literature (UNEP 1999; Pearce-Churchill et al. 2005; and Bhuiya 2013) and feedback from the Pilot survey. The overall ranking was analysed by categories of participants. This was done by taking the arithmetic mean of the responses of each category of participants. The fourth section which was optional required participants to provide any additional comments that were considered relevant to the survey. Follow up telephone interviews with participants were done.

The distribution of the questionnaire was accompanied by a letter requesting participation and advising on the

confidentiality of the responses. Participants were advised to by-pass questions which they considered to be sensitive. For the analysis of data, scores of all variables were averaged to obtain the overall indication of the project success. The perception of specific groups in countries was obtained by grouping participants by country and category. The student t-test and correlation coefficients were used to compare the responses between the different categories.

4. Results and Discussions

4.1 Participants

The results of Section I of the questionnaire and the first two items of Section II, on the level of involvement of participants in RWH confirmed that the criteria for the selection of participants were met. There was 80% response from the target group of which 95% completed all sections of the questionnaire.

The main organisations from which participants were selected included the Organisation of Eastern Caribbean States (OECS), Food and Agriculture Organisation (FAO), Global Water Partnership-Caribbean (GWP-C), the St. Vincent de Paul of the Catholic Church, United Nations Environment Programme (UNEP) and University of the West Indies (UWI). The selected participants for the survey were considered to be the best persons to assess the success of DRWH projects if they had more than 3 years working experience in the field. To facilitate the analysis, the participants were categorised into five main groups as shown in Figure 1, were from the following islands: Organisation of Eastern Caribbean States (Antigua and Barbuda, Carriacou, Grenada, St. Vincent and the Grenadines, Saint Lucia, Dominica,), Trinidad and Tobago, the Virgin Islands and the others (Jamaica, Barbados, Guyana and the Bahamas) as shown in Figure 2.

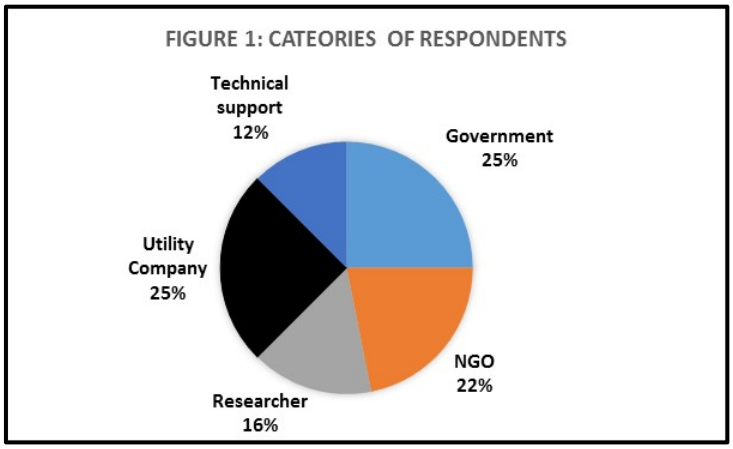

Figure 1. Categories of respondents

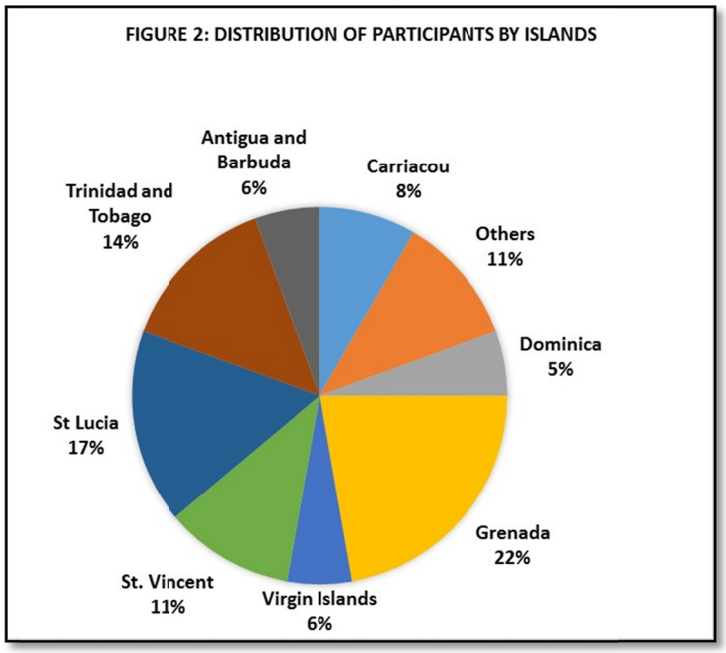

Figure 2. Distribution of participants by Islands

In this study, 53% of the participants' experiences were limited to RWH for domestic purposes, 3% for agriculture purposes and 44% for both domestic and agricultural purposes. Forty eight percent of the participants were involved in the RWH sector for more than 10 years while another 30% were involved for between 3 years and 5 years. More than half (52%) of the participants used RWH on a regular basis and considered it their primary source of freshwater, while 36% used it occasionally, and only 14% considered themselves non-consumers of harvested rainwater. Although 75% of the participants were willing to invest at the personal level in RWH, only about 60% of these were willing to make that investment even if the water from the RWH system was more expensive than that of that public supply. Overall, 80% of the participants considered themselves having an excellent knowledge of RWH with the remainder claiming good knowledge**.** Based on the responses to the first section of the questionnaire, the overall characteristics of the participants suggest that they are likely to be good promoters for RWH and good judges of whether DRWH has been successful.

4.2 Support for RWH

In order to expand the use of RWH, adequate general support from key stakeholders is required. The study showed that the experts in RWH, as identified for this project, concluded that the support from some key stakeholders is weak and from the responses, the strongest support came from the beneficiaries and users of RWH, particularly in the islands where RWH is well developed (Figure 3). This may be expected as this group has direct benefit. More than half (52%) of the participants were of the view that users were willing to spend their own money to maintain and upgrade their RWH systems while only a minority (12%) were of a contrary view. The other participants were non-committal. The willingness to invest in maintenance and upgrade of RWH systems was highest among participants from Carriacou and St. Lucia. In the case of Carriacou, this may be explained by the high familiarity with DRWH since RWH has been well established on this island for some time, whereas in the case of St. Lucia recent activities in the promotion of DRWH may have enhanced public awareness. The lowest indication of willingness to invest was found to be in St. Vincent, where water supply was generally satisfactory.

The weak support from users (Figure 3) was reported mostly by the participants who were from islands where RWH has not been widely utilised previously. This weak support is reflected in a poor rate uptake of the technology to date, notwithstanding a number of projects undertaken in these islands during the last decade and may be due to satisfactory public water supply in those islands. From the survey it was suggested from the study that where higher level of support was observed from the users of RWH, this can be capitalised such that their involvement and local knowledge could influence costs and allow for innovative improvements of current

systems.

The least overall support for DRWH was from the governments**.** The view of a low level of support from the governments was a view supported by 75% of participants who represented governments. Further, there was consensus (88% strongly agreed) that government support is critical to the success of RWH projects. A minority (12%) of participants observed that little support is given to small communities where the practice of RWH is not well established.

International NGOs and regional and international development agencies have provided mostly moderate to strong support which was acknowledged by all categories of participants. While overall, there is support from international NGOs and regional and international agencies for the development and enhancement of RWH, 28% of participants considered that there was too much dependence on these bodies. At the same time, there is an observation among a minority (23%) of participants that RWH projects failed on the departure of sponsors. Put simply, beneficiaries abandoned the projects or neglected to adequately maintain the RWH systems, particularly when rainwater generally only supplements a more regular supply**.** This observation is not unique to RWH systems as often in development projects, there is a long standing history of projects failing shortly after the agencies leave due largely to the lack of investment in capacity building (Stergakis, 2011)**.** Failure also occurs as the beneficiaries do not "own" the projects in the first place. Further, there is a larger cultural issue which is based on the thinking that donors will always come in to support these initiatives.

Interestingly, about half (48% of the participants) believed that the growth of RWH depended on the support from the international NGOs. In contrast, support from the local NGOs in the promotion and development of RWH was assessed to be adequate by only 20% of the participants. All told**,** partnering between the regional and international agencies and local NGOs seems to be weak**.** Further, the financial resources available for the development of RWH in the region, were assessed to be adequate by only 16% of the participants and these were mainly government representatives.

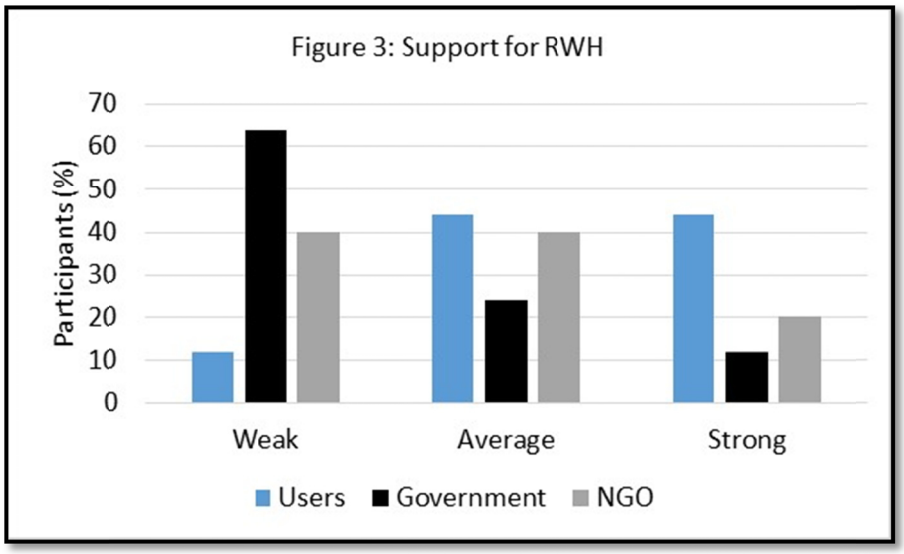

Figure 3. Support for RWH

4.3 Impact of Legislation

The impact of legislation is influenced by both the history of RWH and the motivation for its introduction. Among the islands which have laws requiring RWH are Barbados and the US Virgin Islands. In the U.S. Virgin Islands, the law requires that provision be made in the construction of all new buildings for the capture and storage of rainwater. From interviews with participants from the US Virgin Islands, it was revealed that the stored rainwater is generally fully utilised and is preferable to desalinated water. However, the extent of the influence of legislation on this outcome is not clear. Notwithstanding, the view among leaders in the RWH sector (70% of participants) is that legislation facilitates the growth of RWH and enhances the success of RWH projects**.**

While the impact of legislation is not conclusive, the results of this study suggest that in the Caribbean,

appropriate legislation is likely to enhance RWH development. Nevertheless, there appears to be a hesitation to develop legislation due to the possibility for the use of subsidies for the installation of RWH and a possible reduction in revenue for utility companies (Boodram and Dempewolf, 2015).

4.4 Training

Included in almost all RWH projects are training on systems installation and maintenance, and programmes for public awareness. As shown in Figure 4, most of the participants believed that training was inadequate. This was the case particularly during the post implementation of RWH projects and for the training of community trainers as only 11% and 9% are of the view that training was in the case of post implementation and community training respectively. However, it was generally agreed (60% of participants) that there was increased knowledge of the RWH technology among the communities. Moreover, 82% of participants strongly believed that an increased provision of adequate technical training is important for households to maintain and improve the quality of water from their RWH systems. It was observed by the participants (64%) that households were interested in improving or actually improved their systems through the interaction with neighbours who have been exposed to RWH through formal RWH project**.**

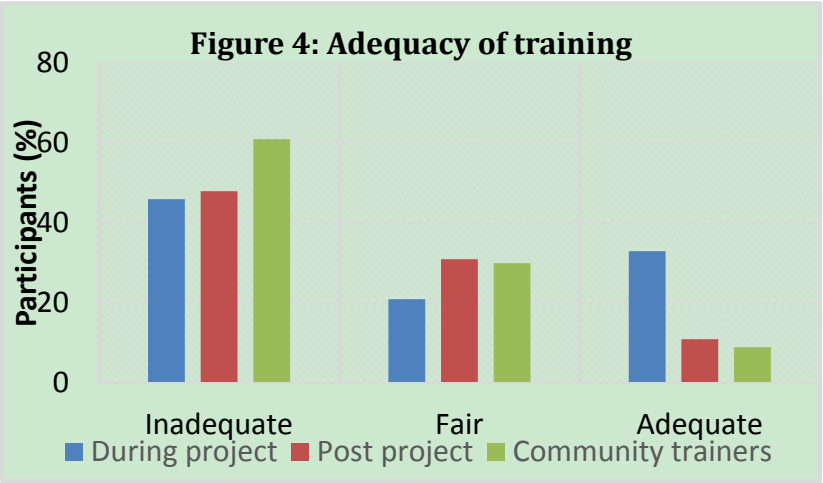

Figure 4. Adequacy of training

4.5 Community Involvement

A significant number of participants (64%) observed that generally RWH projects are intended to be targeted to the communities and individuals that are most vulnerable to water scarcity. However**,** there was doubt as to whether the best individuals or communities were selected, since only 36% of participants indicated that from observations through active involvement with communities, that individuals and communities were poorly selected. The majority of participants were satisfied with the involvement of the individual beneficiaries at all stages of the implementation of the projects, which suggests that beneficiaries are generally consulted at all stages. At the same time, the majority of these participants believed that the general public should be more involved in the development and promotion of RWH projects**.** Only a small portion of the participants reported that the majority of the population does not need to be more involved in RWH projects.

Conversely, 76% of participants believe that the cultural practices of communities are not adequately considered in the design of projects. This may partly explain why there is not a strong sense of trust between the sponsors and developers of the projects and the beneficiaries of RWH projects as suggested by the response of 60% of participants.

4.6 The Selection of Beneficiaries

Although the most vulnerable community might be selected, the success of RWH projects can also be influenced by the socio-economic status of the beneficiaries. Only 24% of participants believed that the beneficiaries were in positions to pay for the costs of electricity and other accessories where these were needed in the RWH systems. Consequently, 70% of the participants agreed that simpler systems would have been more affordable to the beneficiaries of the RWH projects. Further, there was consensus (92%) that greater success would have been possible where projects targeted communities with existing RWH systems. Poor selection of beneficiaries means that greater efforts are required to achieve success. In this regard, there was a majority (64% of participants) view,

that there is often an over-concentration of efforts on projects where there was evidence of failures and as such there are often signs of project fatigue among beneficiaries as indicated by 56% of the participants.

4.7 Success

There has been a number of interventions to enhance the availability of water to water scarce communities in the region. Generally, in this study, participants have a positive perspective about the success of RWH projects (with an average score of 5.2 on a scale 0 to of 7). For the participants who were regular consumers of rainwater their perspective were slightly less positive (with an average score of 4.94 on a scale of 0 to 7). In the case of participants who never used or occasionally used rainwater there appeared to be a more positive view of the success (with an average score of 5.4 on a scale of 0 to 7). However, statistically there is no significant difference in the perception between the groups as the t-test (at α =0.05) of averages of the groups returned a p-value of 0.47. This suggests that the perception of success was not influenced by the regular consumption of DRWH by participants. On the other hand, there was a significant difference in the view of the level of success by participants who represented the government (average score of 6.12 on the 7 point scale) and non-government representatives (average score of 4.89 on the 7 point scale) as indicated by a p-value of 0.009 for the t-test (at α =0.05). As there is often political interest of governments in reporting success of DRWH projects which impact on vulnerable groups, there is likely to be tendency for government officials to report on the success of the projects. Among the different categories of participants, as shown in Figure 1, representatives from the utility companies showed the least positive view of the success of DRWH projects with an average score of 4.2 on the 7 point scale. Further, less than half (46%) of the participants rated the RWH projects undertaken in the past two decades as highly satisfactory. Although the representatives from the utility companies have a more negative about success of DRWH projects, it is important for DRWH to be fully integrated into the management of the islands' water resources. The utility companies must support the stakeholders of RWH projects as these projects can have positive impacts on the people who need water.

Most of the participants (73%) believe that DRWH has the potential to be sustainable and that the technology would be maintained in its present form for the foreseeable future. In the study, 82% of the participants have endorsed the view that evaluation of the success of projects is generally limited to their designated timeframes with few follow-up after the implementation of physical systems**.** The greatest success in DRWH was therefore, identified as taking place in the initial stages of the development of the projects, that is, the mobilisation and awareness raising of communities and in the installation of DRWH systems during which enthusiasm and motivation were found to be the highest.

Among the researchers, there was a perception that progress made in the promotion and development of RWH was less than established targets. Sixty two percent of the participants were of the view that greater success of projects was seen where there was a good match between the scope of the project and the available finances. For RWH projects in the region, a minority of participants (20%) believe that success was not achieved even if technology was consistent with the local culture. Two other key factors identified by the majority of participants as critical to success are (a) project design and implementation that is incremental, and (b) functioning indigenous RWH systems.

Some weaknesses were identified in the design and implementation of RWH projects which hamper success. More than half (68%) of the participants were of the view that too much resources were spent on the administration (salaries of consultants and project managers) of projects and too little on actual management of water. This short coming suggests that the financial resources could be better distributed to the different components of projects. This might require a protocol for the proper allocation of funds.

An important challenge for RWH is the availability of funding. While participants acknowledged the government's role, the main source of funding is from regional and international development agencies. The potential role of entrepreneurs seems to be limited. Only a minority (26%) of participants believe that local entrepreneurs can play a greater role in the development of RWH while about half (48%) of the participants did not see RWH as being attractive enough to motivate investment from local entrepreneurs. This position may be influenced by the current state of RWH development and the level of involvement of the private sector and could therefore be temporary. Unlike what is found in this study, Naugle (2011) found that the private sector In Uganda was well positioned to provide RWH products to meet the demand of householders who are prepared to make investment in the construction and up-grading of DRWH systems. This may be explained by the differences in socio-economic conditions between the Caribbean and Uganda

4.8 Success Factors

Each RWH project goes through a project development analysis by the regional or international funding agency

and critical success factors are routinely identified. The interview with the experts in RWH from the Caribbean, who participated in this study, confirmed that the 14 factors which were identified were important to the success of projects. These factors were rated according to importance on a scale of 1 to 10 where 10 was most important and 1 least important. Table 1 shows the average rating by participants. For the aforementioned success factors (Table 1), the mean value ranged from 5.89 to 8.52 on a scale to a maximum of 10. The standard deviations show that the spread was less than half the mean, with the least variation in the participant's perception of technical support and the most important success factor being the costs of the systems.

The ranking of success factors by participants varied according to institutional association and place of residence, as show in Table 1. One of the top three success factors was identified in each, of the social, technical and economic groups of factors. It must be noted that all categories of participants identified the initial capital costs of installing RWH systems (particularly storage facilities) as the most important success factor. Overall, education and public awareness through training at the school and community levels, appear to be important factors in ensuring success. The least important factor was the educational levels of the beneficiaries.

The correlation analysis shows that the greatest similarity in the way success factors were ranked was between participants associated with water utility companies and those associated with governments. There was a correlation coefficient of 0.462 between the rankings of these groups (See Table 2). Participants employed in research, the NGOs and project sponsor agencies tended to rank in reverse order as indicated by the Correlation Coefficient of -0.392

An analysis of the results for Trinidad, Grenada, the OECS excluding Grenada and the other countries (Table 3) shows that the highest correlation was between Grenada and the rest of the OECS. Among the OECS, the greatest DRWH intervention has been in Grenada. There was almost no correlation (correlation = -0.012) between the order in which the RWH mature islands (Carriacou, the U. S. Virgin Islands and Antigua and Barbuda) ranked success factors and the ranking by the other countries (Jamaica, Guyana and The Bahamas) where formal DRWH is currently not widely utilised or is an early state of formal development. The above observations on the ranking of the success factors suggest that in planning and developing RWH projects due consideration must be given to the particular islands and the engagement of the different stakeholders should take into consideration what are important. Notwithstanding, the success factors as identified in the islands where RWH has developed to a mature state, should be given the highest priority in planning and implementing RWH projects. Such success factors are quite likely to have been determined by individuals with lessons they have learnt from their experiences over a long period.

Table 1. Success factors: Statistics and ranking in order of importance

		Statistics		**RANKING**							
Category	**Success factors**	Mean (N=35)	STD	Overall	Government	Research	NGOs and international agencies	Utilities	RWH mature islands	OECS	Other islands
Social	Involvement of schools	7.78	2.74	5	8	9	2	6	8	2	5
	Educational level of beneficiaries	5.89	2.53	14	14	3	14	8	12	13	13
	Public support	7.70	2.75	13	10	12	8	10	6	11	7
	Training in the community	6.04	2.41	3	5	10	3	2	5	4	2
	Previous experiences with RWH	7.97	2.86	8	5	1	11	2	2	3	14
	Legislation	7.00	3.02	7	13	12	8	7	14	8	9

Technical	Technical support	8.13	1.57	2	3	3	11	1	4	6	3
	Inclusion of a maintenance component in the design	7.78	2.52	4	5	6	4	2	6	4	4
	Follow up activities	6.96	2.71	6	12	3	5	12	12	10	6
	Availability of local tradesmen	7.07	2.23	5	2	11	7	9	3	14	8
Economic	External financial support	6.67	2.45	9	4	12	10	10	8	6	11
	Involvement of the private sector	6.81	2.38	10	11	6	6	14	8	9	8
	Government financial support	6.77	2.90	10	9	12	13	12	8	11	9
	The cost of systems	8.682	1.93	1	1	1	1	2	1	1	1

Table 2. Pair wise Pearson Correlation Coefficient

	Researcher	NGO	Utilities	Government
Researcher	1			
NGO	-0.392	1		
Utilities	0.252	0.40	1	
Government	0.093	0.276	0.462	1

Table 3 Pair wise Pearson Correlation Coefficient

	RWH mature islands	Trinidad	Grenada	OECS
RWH Mature Islands	1			
Trinidad	0.275	1		
Grenada	0.445	0.467	1	
Rest of OECS	0.325	0.528	0.768	1
Other Countries	-0.012	0.242	0.133	0.252

5. Conclusions and Recommendations

The high willingness of representatives of key stakeholder groups to invest in RWH at a personal level has the potential to make them good RWH project champions in their communities. Further, if the participants who are users of RWH are taken as a proxy for the general beneficiaries and users of RWH, then it could be concluded that there is a potential for investment in RWH projects by individuals.

The support from the different stakeholders varied. For example, financial support from government was generally low for ongoing RWH projects. While improved financial support from government could enhance the success of RWH projects, there appears to be no strong desire by governments to do so. Overall, the study found that if general support for DRWH could be maintained and further enhanced, then there is the potential for better growth of DRWH projects.

In DRWH development, the greatest success can be found during the phases of the projects that relate to capacity building and the delivery of pilot projects. Further, the success of projects seemed to be highest in communities where the use of rainwater was already well established. Consequently, selection of beneficiaries' community is important to ensuring success.

The top six success factors for RWH projects were identified in the study as: the cost of affordable systems; involvement of schools; provision of technical support; inclusion of a maintenance component in the design; training in the community; and undertaking follow up activities. Although the cost of DRWH systems is the most important factor for the success of DRWH projects, overall, technical issues appear to be no less important than social and financial issues. Training and public awareness (TPA), has also been identified as an important success factor. While TPA are now included in DRWH projects, it was generally agreed that the greater integration of TPA in the projects increases the chances of success of the overall project. This is important in enhancing confidence in the use of the water and its consumption which can lead to greater care for the systems

and ultimately their sustainability. This finding is consistent with research carried out in the Cameroon where the two main challenges of up-scaling RWH was costs of systems and awareness (Folifac *et al*., 2013).

Notwithstanding the absence of conclusiveness of legislation in the literature as a success factor for RWH, in this study it is a middle ranked success factor. There are no specific policies or legislative provisions to support RWH in some of the islands (Government of Grenada, 2012). If future RWH projects are to be successful and sustainable consideration should be given to enacting appropriate legislation that can help create an enabling environment.

Finally, it is recommended that in the conceptualisation and design of future RWH projects in the region, these success factors identified in the study should be given adequate consideration particularly those related to the long-term performance of the systems.

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