International Journal of Engineering Applied Sciences and Technology, 2019
Vol. 4, Issue 5, ISSN No. 2455-2143, Pages 384-389
Published Online September 2019 in IJEAST (http://www.ijeast.com)

FEASIBILITY AND ACCEPTABILITY STUDY OF RAINWATER USE IN THE SOUTHWEST COASTAL AREA OF BANGLADESH

M. M. Rahman
RAiN Forum, Dhaka-1205, Bangladesh

M. A. Alum, S. A. Haq
RAiN Forum, Dhaka-1205, Bangladesh

Abstract— **Water Scarcity is hampering in every sphere of the lives of the people living in the coastal area of Bangladesh. Though there were ample government interventions to bring about a positive change, but these interventions lacked efficiency and sustainability. This Study represents the feasibility and acceptability of harvested rainwater in rural communities of Bangladesh as well as costal area, using simple and modern technology. As a part of this study, a field survey was conducted in the water-scarce of costal area. 33 places in different five unions of Shyamnagar upazilla were selected for conducting questionnaire survey. A questionnaire was developed to know some information such as the socio-economic condition, family information, housing condition, sanitation condition, health condition, economic condition, existing water supply condition, knowledge about rainwater, willingness to accept rainwater, etc. almost three thousand two hundred people from different family were selected randomly. Secondary data was also collected to know the actual rainwater availability and storage conditions, which were used to justify the effective tank size. Only the roof of public buildings including mosque, UP office, School, College etc. are consider as the catchment for rain water harvesting. Feasibility analysis was performed using the survey results and the research findings. The study showed that the rainwater harvesting technique was feasible and acceptable to the people in the coastal area as the only potential alternative source of safe drinking water.**

Keywords— **Coastal, Rainwater, Scarcity, Harvested**

I. INTRODUCTION

Water is not only essential to life and human health but also plays an important role in economic development, food security, poverty reduction and sustainable ecological functions [1]. The world's population is increasing day by day and expected to reach eight billion by 2025. Growing demands on drinking water supplies and water for food production are evident, and competing uses of limited resources are inevitable [2]. Climate change impacts of higher temperatures, drought are expected to intensify water demands [3]. About 97% of the population depends on underground sources for drinking water [4] and about 20 million people of the coastal area are affected by salinity in drinking water in Bangladesh [5]. Scarcity of safe drinking water is an increasing problem in the southwestern coastal areas of Bangladesh. Most of the people collect water for drink purpose from pond. But day by day, the freshwater ponds are also contaminated by horizontal saline intrusion. all water sources became dysfunctional by tidal surge in the coastal areas of Bangladesh after the hit of Cyclone-Sidr and Cyclone-Aila. Therefore, the existing fresh water sources, both surface and groundwater, became contaminated by either salinity or bacteria [6]. So nowadays, people particularly women and girls are to walk to several kilometers for collecting water for drinking which has impacts on women's safety, education, health risks, and micro-economy of individual family.

Rainwater harvesting can be considered as a probable solution of drinking water crisis in arsenic affected areas, saline zone in the coastal areas, and areas prone to groundwater depletion. There are considerable scopes for harvesting of rainwater during monsoon period to minimize the water-scarcity related problems. Many research works are going on the potential of rainwater harvesting and the urgency of mitigating water-scarcity related problems. There is a huge potential of potable water savings and preservation of water resources through rainwater harvesting in 62 cities in Brazil [7]. Rainwater harvesting is defined as a system which has been practiced for centuries for collecting of rainwater instantly making sure that it does not run off into river or stream or does not soak into the ground or does not become contaminated [8, 9]. The physical, chemical, and bacteriological properties of harvested rainwater usually show a suitable and acceptable standard of potable water. Rainwater is safe too if it is maintained hygienically and free from salinity, arsenic contamination. Harvested rainwater can be used in drinking, cooking, washing, and bathing purposes [10]. Due to geographic location, a tropical monsoon climate prevails in Bangladesh that has made it one of the wettest countries of the world. The mean annual rainfall in Bangladesh is about 2320mm [11]. Theoretically 20% of the total rainfall collected during the monsoon might satisfy almost the whole of Dhaka city's demand [12].

International Journal of Engineering Applied Sciences and Technology, 2019
Vol. 4, Issue 5, ISSN No. 2455-2143, Pages 384-389
Published Online September 2019 in IJEAST (http://www.ijeast.com)

II. BACKGROUND OF WORKING AREA

Bangladesh is a disaster prone country where the intensity of disasters is maximum in its southwest coastal region. Satkhira, due to its geographical settings are exposed to major threats of the disasters that this region encounters. To worsen the situation, from the available secondary sources, it has been found that the Satkhira district of the southwest coastal regions is one of the most vulnerable regions of the country in case of fresh water crisis which is caused by the high presence of salinity in its surface and ground water. The area under study is 5 unions (Atulia, Burigoalini, Munshiganj, Koikhali, Ramjannagar) in Shyamnagar Upazila of Satkhira district. The maximum area possible within these 5 unions were opted to cover. Therefore the unions were selected based on its geographical boundaries. The 5 largest unions of the Shyamnagar were divided into 33 location to prefer work.

III. METHODOLOGY & COMPONENT

To study the prevailing condition in the locality in respect to water crisis the social research methodology was adopted. The techniques were:

- Transect Walk
- Questionnaire Survey
- Focus Group Discussion (FGD)

Transect Walk:

The study initiated with a transect walk around the working area. Accompanying some key local people and tried their level best to observe the overall condition in the working areas, i.e. the 5 unions of Shyamnagar upazila. Based on the findings of the transect walk, an overall condition, problems and challenges of the operating water sources were detected and at the same time a rough idea was got about possible solution for the concerned locality and also locate the specific working area. The findings of the transect walk revealed 60 different sites within these 5 unions where the intensity of fresh water crisis is extremely high and immediate steps needs to be undertaken in order to minimize and mitigate the sufferings of the local residents.

Questionnaire Survey:

Once completed with the transect walk, conducting questionnaire survey was focused in the working area. It was ensured that a diverse range of participants in the survey and thus ensured that survey was done by both men and women irrespective of their class or age. In the questionnaire survey, the local people were asked about their problems related to water and also the problems they encounter on consumption of water from the available sources. Apart from their hurdles, their opinion was gathered regarding the solution to these crises.

Focus Group Discussion (FGD):

The FGD was the then conducted with the key local figures. They were also asked about their opinion and experiences regarding the available water sources and also from them got to know about their preferences regarding the best water option.

Available Rain Water Volume Calculation:

Since setting up/installing and measuring the capacity of the new water options is completely a technical task, some basic calculation is required. Available Rain water during monsoon period is also calculated by the following equation.

Volume of Rain Water, $V\ (m^3) = I \times A \times C$…….(1)

Where,

I= Annual Rainfall intensity in meter

A= Roof area of the proposed buildings in m^2

C= Runoff Co-efficient

IV. ANALYSIS & FINDINGS

The social findings:

Struggle for safe drinking water has been a regular routine of the local people's lives. After conducting the survey and carrying intense discussion on the matter of water crisis, it has been found that, a significant amount of time is lost daily for fetching fresh water. It was learnt that people at time requires to walk for 2-3 km. to avail fresh water. Not that it is only painful and involves huge physical labor but it takes away a huge chunk of time from their lives affecting their household and economic activities. But still at times, collecting water from 2-3 km away from home cannot ensure 100% fresh water. Life cannot be much more painful when this poverty struck population are forced to buy fresh water. As we all know, Satkhira in the 7th ranked poorest district of the country and people here are victim of extreme poverty. Every single penny matters for these people. The natural calamities, environmental degradation and the unfavorable natural settings hamper the economic activity of the local people immensely. Paying for water on a regular basis turns out to be enormous burden for these people who are living below the poverty line.

The acute shortage of fresh water:

Survey reveals that acute shortage of fresh water prevails in the concerned area. But there is no way out that one can manage without fresh water. So they had to overcome all the barriers and hurdles and travel long distance or pay a huge amount of money to avail fresh water. But question arises when the survey reveals that there is high presence of water borne diseases in the studied area. People are availing fresh water but still suffering from water borne diseases. This is an impossible fact. This can be only possible if the water these

International Journal of Engineering Applied Sciences and Technology, 2019
Vol. 4, Issue 5, ISSN No. 2455-2143, Pages 384-389
Published Online September 2019 in IJEAST (http://www.ijeast.com)

people are consuming is actually contaminated. This implies that the existing fresh water sources are failing to serve its purpose. From survey it reveals that the majority of the people or his/her family members suffered from water borne diseases. People are regularly being affected by diarrhea, jaundice, fever, stomach ache, high blood pressure or skin diseases. Females experiences menstrual problem and also encounters problems during their pregnancy. All these are sign of drinking contaminated water.

Challenges of the most popular fresh water option (PSF):

Thus from the survey results, it is now quite evident that the available fresh water sources are failing to serve its purpose and majority of the people are exposed to contaminated water. Therefore, it was the primary responsibility to search and examine the available water source. From the response of the local it was got to know that the most popular source of water for them is the existing PSFs. More than 80% of the surveyed population manages their drinking water from the PSFs. While getting to inspect these PSFs it was found that the exposure of the PSF to the environment and the different natural calamities are contaminating the water sources. During the visit to the locations it was found out that humus in the form of falling leaves and surface runoff are also making the water contaminated. Moreover, the water color of the ponds where the PSFs are installed reveals that the water is high on nutrients. This automatically implies there is a connection between sewerage line and the pond. Thus these ponds become highly contaminated and fail to offer fresh water.

The most dependable water option (Rainwater Harvesting System):

The local people are also aware of the fact that they are not getting the access to fresh water. While they were surveyed regarding their opinion, PSFs might the most popular source of water but the local people believes that Rain Water is the purest form of water. Since they are now encountering daily problems with water availed from PSFs, they surveyed population now feels that their water crisis can be managed and mitigated through installation of rainwater harvesting system.

From the survey it has been revealed that many girls are burdened with the responsibility of fetching water for household from distant place which forced them to skip classes. If the rainwater harvesters are installed in the school arena, then these girls will not have to skip their classes to collect the water but will collect the water while they return to home after finishing their school.

Previously, some of the rain water harvesters installed at the household level had become unusable due to lack of maintenance. But if the rain water harvesters are installed in the public institutions, then the institution itself will maintain the water option. Thus longevity of the water option will be ensured.

Primarily 60 different potential sites were selected where there is need of rain water harvesters. Then a study was in detailed digital survey to test the feasibility of the rain water harvesting system in these 60 sites and finally it came to conclusion that there are 33 sites which are suitable for installing rain water harvesting option. Then the key persons of these 33 public institutions were contacted and wanted to know their opinion. They readily promised to ensure the access of the local people to rain water harvesters. They are also committed to take the responsibility of the maintenance of the installed rainwater harvesters.

In fig. 2, it has been revealed that around 60% of the families studied has 4-8 members in their family. Around 25% of the families have 8-12 members. While the rest of the population studied, either has more than 12 members in their family or have less than 4 members in their family. From the findings of the survey, it can be stated that a family, in the working area, on an average has around 7-8 members.

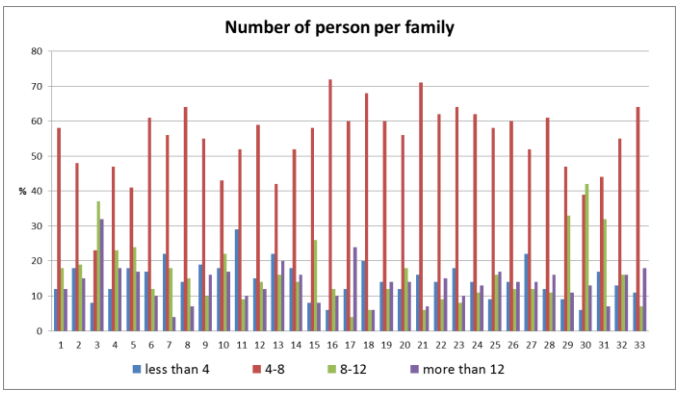

Fig 2: Number of person per family

The findings reveal that around 80% of the population is managing their drinking water from PSFs [Fig. 3]. The rest of the population surveyed consumes water which are collected directly from the pond. A very few families are using RWHS as a source of fresh water.

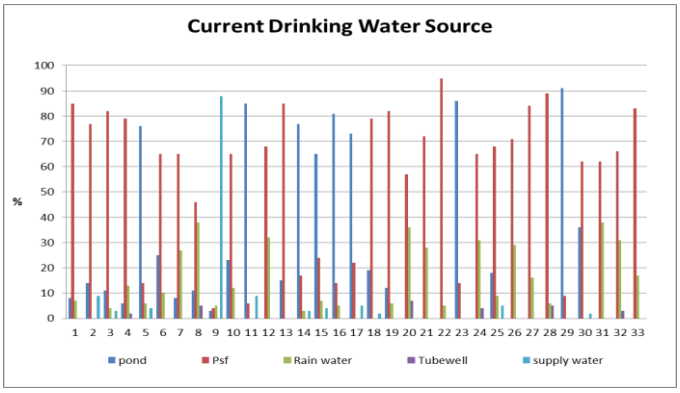

Fig 3: Current Drinking Water Source

In fig. 4, it has been revealed that on an average, a family consumes around 8-10 liters of water per day which is quite

International Journal of Engineering Applied Sciences and Technology, 2019
Vol. 4, Issue 5, ISSN No. 2455-2143, Pages 384-389
Published Online September 2019 in IJEAST (http://www.ijeast.com)

standard for families with 7-8 members. To add on, majority (80%) of the respondents said that in his/her family consumes 10-12 liters of water every day. The rest 20% of the respondents either consumes more or less than 10-12 liters of water every day.

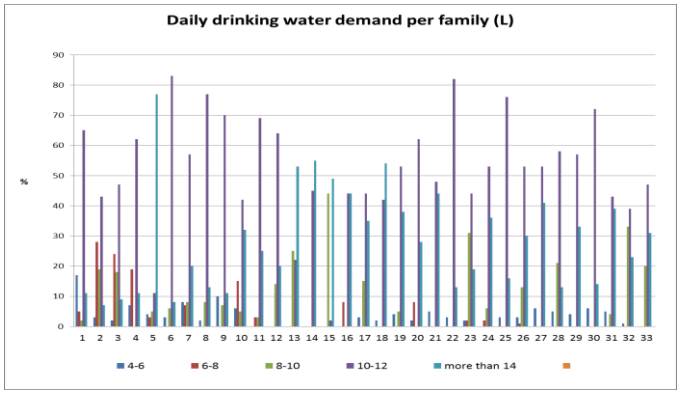

Fig 4: Daily drinking water demand per family

From the findings here, it has been revealed that maximum of the surveyed population has a fresh water source within 200 meters from their home. But they don't have any clue that where these water options are fulfilling its purpose of offering fresh water or not. Then again around 7% of the surveyed population has to travel more than 3km to collect fresh water. Around 15% of the surveyed population needs to travel 2-3km in search of fresh water. Travelling 2/3 km is a quite a huge distance and involves a lot of labor. At the same time, it consumes at least few hours from their daily life.

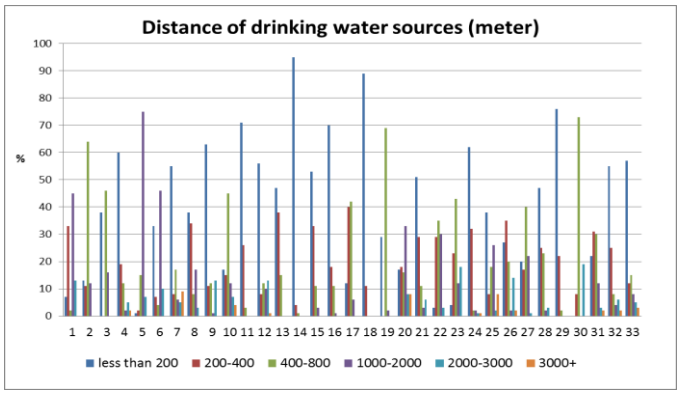

Fig 5: Distance of drinking water sources (m)

It has been reported by around 50% of our respondents that water scarcity is maximum during March-April period of the year. While the rest believes that scarcity of water is maximum only during the month of April when the season is completely dry.

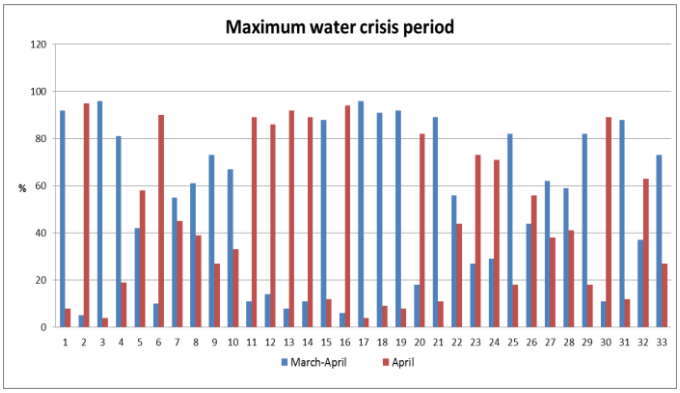

Fig 6: Maximum water crisis period

Fig 7 represents that more than 90% of the surveyed population does not apply any purification technique for consuming the water. Rarely the person surveyed boils or uses fitkiris to purify their water. Few of the respondent's uses filter machines to purify their drinking water.

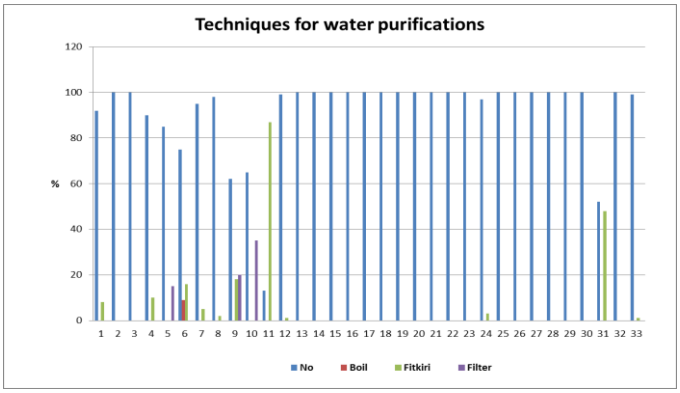

Fig 7: Techniques for water purifications

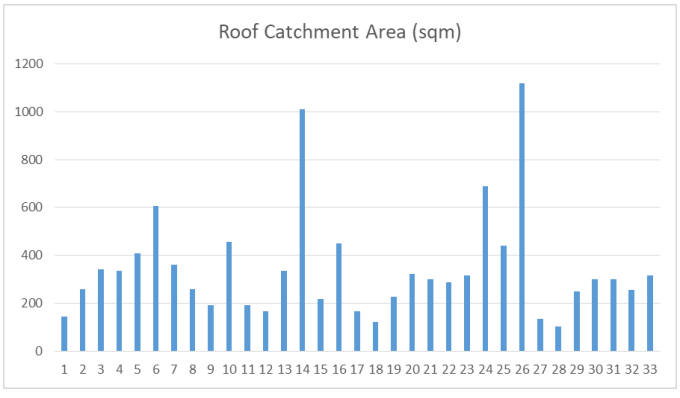

Fig 8: Available Roof Catchment Area (sqm)

Fig 9 represents that 45% of the surveyed catchment are needed to repair and rest of catchment are very good.

International Journal of Engineering Applied Sciences and Technology, 2019
Vol. 4, Issue 5, ISSN No. 2455-2143, Pages 384-389
Published Online September 2019 in IJEAST (http://www.ijeast.com)

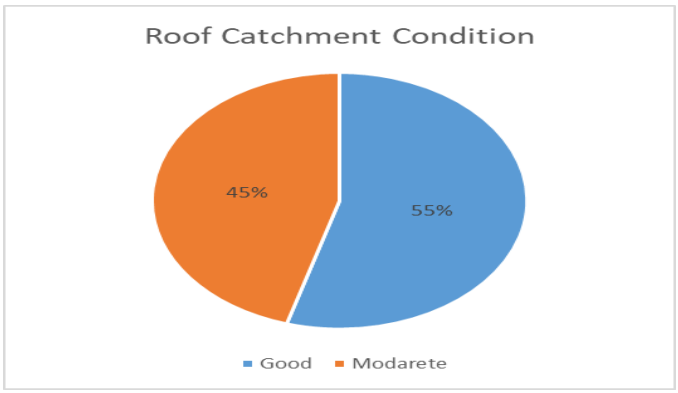

Fig 9: Roof Catchment Condition

It was found that an average water requirement for drinking purposes was 2 liters/day/person (Kahn and Stralka 2008). Fig 10 & 11 represents that 50% of the surveyed population can fulfill their water demand in 6 month's dry period by the harvested water from the surveyed catchment.

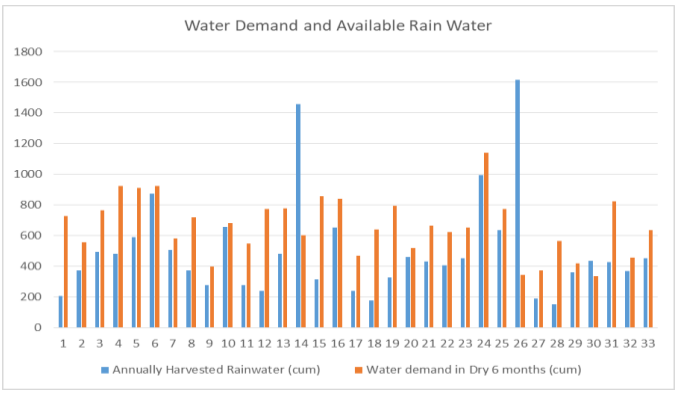

Fig 10: Available Rain Water and Water demand for Dry Period

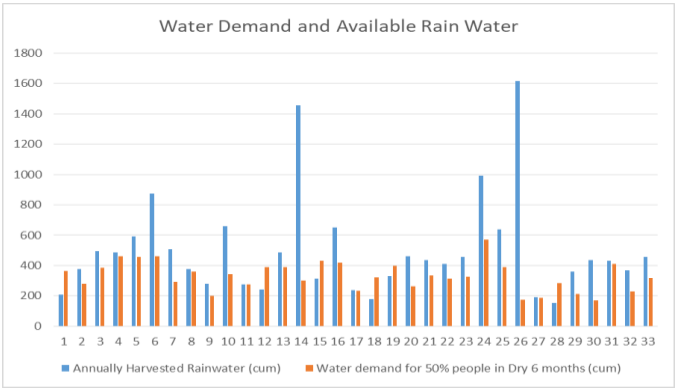

Fig 11: Available Rain Water and Water demand for Dry Period for 50% of total people

V. CONCLUSIONS

From this research, it is clear that there is extreme scarcity of safe drinking water. People at times need to walk for several kilometers before they can gain access to fresh water sources. The rainwater harvesting is a very useful and acceptable alternative water source. Also in the scarce safe drinking-water areas, it is very useful. The people are willing to have the system if they get some Government incentives because the initial installment cost is higher compared with their monthly income. They were not satisfied with the existing water source. The quality of water is not good and they face a lot of problems to collect the water. They cannot not boil the water, because it costs extra money. As the rainwater quality was acceptable as drinking water, the people are willing to accept the rainwater as alternative water source. Some people have previous knowledge about the rainwater.

VI. ACKNOWLEDGMENTS

The authors are very much thankful to RAiN Forum and Water Aid Bangladesh for facilitating the research.

VII. REFERENCE

[1] United Nations Water (2013), Water security & the global water agenda: a UN-water analytical brief. 2013. http://www.unwater.org/downloads/watersecurity_analyticalbrief.pdf.

[2] United Nations Development Programme. Human development report: beyond scarcity: power,poverty and the global water crisis. 2006. (ISBN 0-230-50058-7). http://hdr.undp.org/sites/default/files/reports/267/hdr06-complete.pdf.

[3] Parry M, Canziani O, Palutikof J,van der Linden P, Hanson C, editors (2007), Climate change: impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change. Cambridge: Cambridge University Press;. 469–506.

[4] SHAMSUDDUHA, M. (2013), Groundwater-fed Irrigation and Drinking Water Supply in Bangladesh: Challenges and Opportunities.

[5] VINEIS, P., CHAN, Q. & KHAN, A. (2011), Climate change impacts on water salinity and health. Journal of Epidemiology and Global Health, 1, 5-10.

[6] Bangladesh Convention of Rainwater Harvesting, 2012. http:// www.rainwaterconvention.org/.

[7] E. Ghisi, A. Montibeller, and R. W. Schmidt (2006), "Potential for potable water savings by using rainwater: an analysis over 62 cities in southern Brazil," Building and Environment, 41 (2), 204–10.

[8] K. H. White, L. R. Soward, and G. Shankle (2007) Harvesting, Storing, and Treating Rainwater for Domestic Indoor Use, Texas Commission on Environmental Quality, Austin, Tex, USA.

[9] C. Kloss (2008),"Managing wet weather with green infrastructure: municipal handbook- rainwater harvesting policies," Tech. Rep. EPA-833-F-08-010, Environmental Protection Agency.

[10] B. K. Biswas and B. H. Mandal (2014), Construction and Evaluation of Rainwater Harvesting System for Domestic Use in a Remote and Rural Area of Khulna, Bangladesh. Hindawi Publishing Corporation International Scholarly Research Notices, 751952, 6, http://dx.doi.org/10.1155/2014/751952

[11] S. B. Murshed, A. K. M. S. Islam, and. S. A. Khan, "Impact of climate change on rainfall intensity in Bangladesh," in Proceedings of the 3rd International Conference on Water and Flood Management, Dhaka, Bangladesh, January 2011.

[12] M. R. Kabir and I. M. Faisal, "Indigenous practice for water harvesting in Bangladesh," in Proceedings of the Regional Workshop on Traditional Water Harvesting System, Tehran, Iran, 1999.