International Journal of Natural and Social Sciences
Print: 2617-6637 < ISSN > Online: 2313-4461
IJNSS

Rainwater harvesting potential in Cox's Bazar to reduce groundwater usage

Nadeem Kazmi

Rainwater Harvesting Advocate, Portland, Oregon the USA

ARTICLE INFO

Article history

Received: 11 November 2020
Accepted: 27 November 2020

Keywords

Rooftop Rainwater Harvesting, Ground water extraction, Rain water catchment, water storage

***Corresponding Author**

Nadeem Kazmi
nadeemgis@gmail.com

ABSTRACT

Rainwater harvesting is an old-aged water collection method in geographic locations where rainfall is abundant. Bangladesh has a tropical monsoon climate characterized by heavy seasonal rain. Cox's Bazar is located on the southern tip of Bangladesh and receives higher rainfall than the national average. Without considering the sustainability, people in Chittagong and other urban areas in Bangladesh are still reluctant to use this abundant source. The scenario of Chittagong city is closer to a condition where the city might face a permanent water crisis, once the underground aquifers go down below the pumping level or the aquifers become dry. In addition, extensive use of groundwater in Cox's Bazar due to the influx of Rohingya refugees has depleted the groundwater to dangerous levels. Rooftop rainwater harvesting in Cox's Bazar would help to reduce the dependence on groundwater tube-wells. The role of local government regarding finance, training, awareness campaign and policy about rainwater harvesting needs to improve in utilizing rainwater for reducing dependence on groundwater tube-wells.

INTRODUCTION

Rainwater harvesting, stormwater harvesting are the alternative water supply options for reusing water and wastewater like black water, grey water recycling are the options for recycling for water management (Ahmed & Arora 2012).Among these options rainwater harvesting offers an ideal solution in areas where there is sufficient rain but inadequate ground water supply and surface water resources are either lacking or are insufficient (Haque 2011).Rainwater harvesting is a simple and low-cost technique that can utilize these rainwater as a resource to solve water crisis. In countries like Bangladesh, where annual rainfall is high, rainwater could meet a significant amount of total demand.

The groundwater table in Chittagong City is at present in a position from where it is difficult to pump groundwater by shallow tube well. Profound tube well is required practically in each place to locate the fresh water from the ground. For the most part, the area, profundity, size, and piece of aquifers are dictated by seasonal rainfall intensity. Some areas in Chittagong experience a great depletion of groundwater level which is shown in (Mirdad & Palit, 2017).

The United Nations Development Program (UNDP) released the study on the groundwater depletion around Cox's Bazar in 2019, stating that the water table around the Rohingya camps close to Cox's Bazar has depleted by 5 to 9 meters. The main reason for groundwater depletion is the installation of around 5,731 tube-wells between August and December 2017 to supply drinking water to the Rohingya refugee camps. Due to the sudden rise in groundwater extraction, the water table is depleting faster than it can replenish (UNDP, 2019)

In such a scenario, rooftop rainwater harvesting could be an option to cut the dependence on groundwater, especially in Cox's Bazar tourism district, where the water usage is higher during the

How to cite this article: Kazmi N (2020). Rainwater harvesting potential in Cox's Bazar to reduce groundwater usage. International Journal of Natural and Social Sciences, 7(4): 01-08. DOI: 10.5281/zenodo.4361878

tourist season. Reducing the groundwater consumption by using rainwater will help to replenish the water table and improve the overall water demand and supply budget of Cox's Bazar city and its surrounding area.

SCOPE OF THE STUDY

Comparatively higher rainfall occurs in the eastern part of the country and lower in the western part of Bangladesh. Scope of rainwater harvesting in a particular area depends on the availability of sites, climatic conditions (specially rainfall) and catchment characteristics. Reliable rainfall data of a certain period in a given catchment is required to design the potential rainwater supply of that catchment.

The eastern part of the coastal area and hilly area of Bangladesh both have serious water source problems but both lie in high rainfall areas. Cox's Bazar gets abundant rainfall during the monsoon season and has a lot of potential to collect and use rainwater in the wet season and store for the drier months. In Cox's Bazar, the average annual rainfall is 3770 mm / 148.4 inch (BMO, 2018) which is much higher (1,334 mm) than the average annual rainfall of Bangladesh varies from 2200 mm to 2800 mm (World Bank, 2019). This amount makes rain water harvesting an obvious solution for reducing groundwater use in this area.

METHODOLOGY

This study looks at the potential of rainwater harvesting for domestic use by applying the rainwater collection method. For this study, rooftops of hotels, government office buildings, hospitals, and mosques were selected. The water consumption in these buildings, on average, is higher than the private home residents.

Figure 1: Area selected for the study in Map (Google view)

Site selection

Four areas near the beach and two inland near the residential neighborhood within the five-kilometer radius in Google Earth imagery were selected and calculated the area rooftop area.

The beach area buildings are hotels and inland buildings consisting of government buildings, mosques, and hospitals. The image (Figure 1) below shows the building's rooftop area (catchment area). Area A, closer to the beach, has ten hotel buildings, and the rooftop area of these ten buildings is 254.57 m². Area B is 115.45 m². Area C east of the beach is approx 62.3 m². Area D further east is a government hospital, and the rooftop area is 45.2 m². The rooftop or the catchment area is critical in calculating the amount of rainfall.

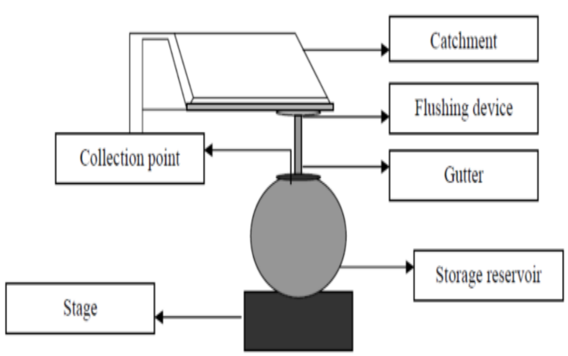

Figure 2: Rainwater system components

The rainwater system components consist of roof surfaces and gutters to capture the rain and send it to the storage system (Figure 2). The storage system consists of an inlet filter to catch large debris. If there are significant rainfall variations throughout the year, a larger tank is necessary to store rainwater during wet months for use during the drier months. In the case of Cox's Bazar, the monthly (12 months) data from 2000-2016 shows that Cox's Bazar receives heavy rain from May to October and witnesses dry periods from November to April (Figure 4). In such a situation, the sizing of rainwater storage is critical to compensate for the drier months. The formula used to calculate the rainwater amount collected uses a coefficient derived from the roof (catchment) surface material. In the study, the roof surface is concrete, and it's a ratio of 0.623 (CCTWG, 2011). The formula to calculate rainwater is the rooftop size (catchment) multiplied by the amount of rainfall during a month. The month & rainfall graph of Cox's Bazar shows that the primary rainy season (June-October) accounts for 70 -85 % of the annual rainfall. Cox's Bazar receives over 2,000 mm rainfall during the monsoon season. The monthly average rainfall from May-October is 574.4 mm.

Potentiality of Rainwater harvesting

Rainfall is an unpredictable variable to calculate the potential of rainwater harvesting of an area. In this study, average monthly rainfall of 17 years (2000-2016) from Bangladesh Meteorological Department (BMD) was used (Figure 3).

The rooftop of the buildings was considered a catchment. The rain that falls on this rooftop was considered for calculating the rainfall potential. Rain falling on ground was not considered as it often carries contamination. The capacity of the underground storage tank was calculated during the survey.

The average monthly rainfall was used to calculate probable supply of water from rainwater. Rainwater calculation is based on the assumption that rainfall events will be evenly distributed throughout the month. But the analysis based on such assumptions may not fully comply with the actual scenario as the distribution of rainfall often varies and is not uniform.

Rainwater harvesting potential was measured by using the formula

Runoff (Potential for Harvesting) =A x R x C
Where,
A =Area in sq. m
R = Annual Rainfall in mm
C =Runoff Coefficient

Others formula that have been applied for calculation of rainwater

Amount collected (litres) = Roof Area (m²) * Rainfall amount (mm) * 0.623

Rainfall Amount Collected (litres) = 476(m²) x574.4 (mm) x 0.623

Rainfall collected during the rainy season (May-October) 170,337.17 liters.

RESULTS AND DISCUSSION

The tank size is calculated by factoring the water demand of businesses located in the buildings. Hotels in Cox's Bazar are busy during the summer vacation season and the rainfall is heavy during this period. Suppose if the occupancy of these hotels during summer is 10,000 guests and if we divide rainwater collected 1**70,337.17 by 10,000 = 17 liters** of water for each guest use. According to the UN, per person requires 50 -100 liters of water per day. For our study, 17 liters of water per person can be used for toilet and shower usage. Switching to rainwater from groundwater for 5 to 6 months will help replenish the water table. Further research is needed to study the potential of rain for recharging shallow groundwater. There are some promising studies done on rainwater recharge systems in Nepal by WaterAid (WaterAid Report 2011). Due to a lack of water demand data, this study will focus on the supply side to explore the potential of collecting rainwater for domestic use. The storage size of the tanks can vary depending on the size of the buildings. Underground tank systems are used in the hotel industry to store rainwater and use in cooling water towers, especially in summers.

The initial consideration of the feasibility of rainwater harvesting system concerned water availability as compared to its use or demand. The supply of the system depends on how much rainfall occurs during the year and the variability of rainfall. The demand imposed on the system depends on water use. If the supply exceeds the demand, then the rainwater harvesting system would be feasible from a technical point of view (UNDP – World Bank, 1990). The study showed that the rainfall in the study area is sufficient to meet the demand by the inhabitants.

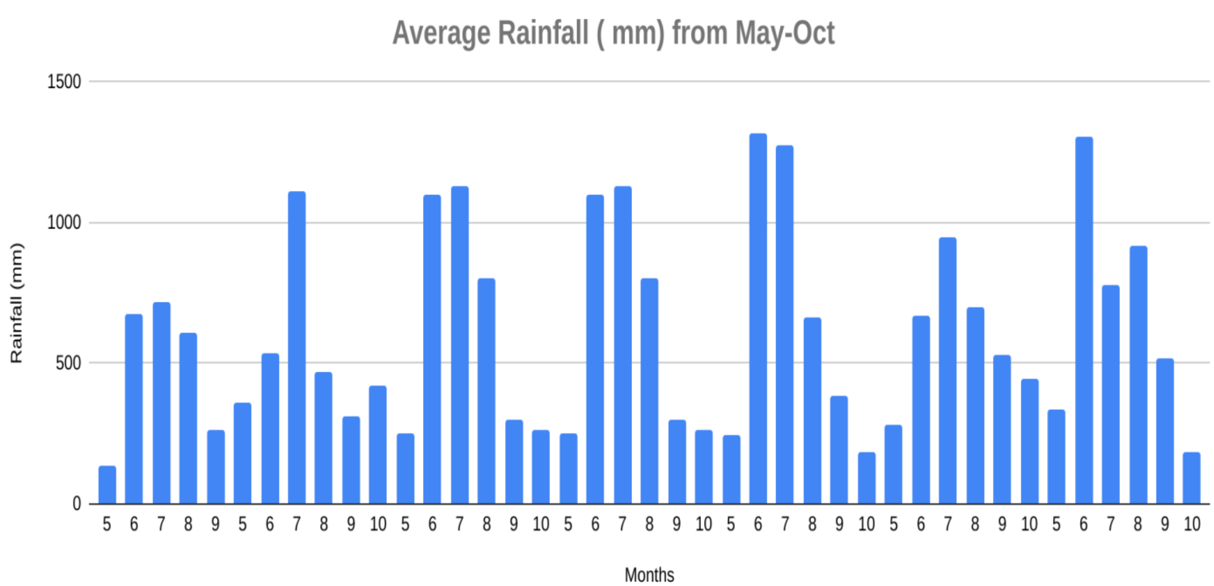

Figure 3: Average Rainfall and months (May-October) from the year 2000-2016

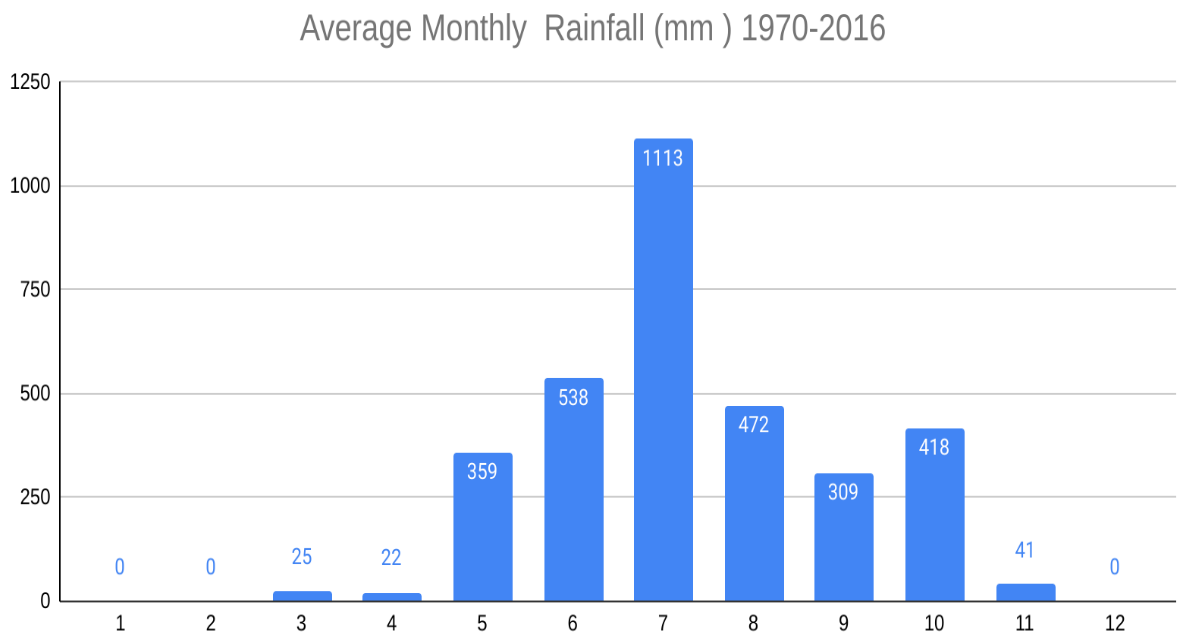

Figure 4: Average Monthly rainfall (mm) from the year 1970- 2016 (Water Aid, 2012*)*

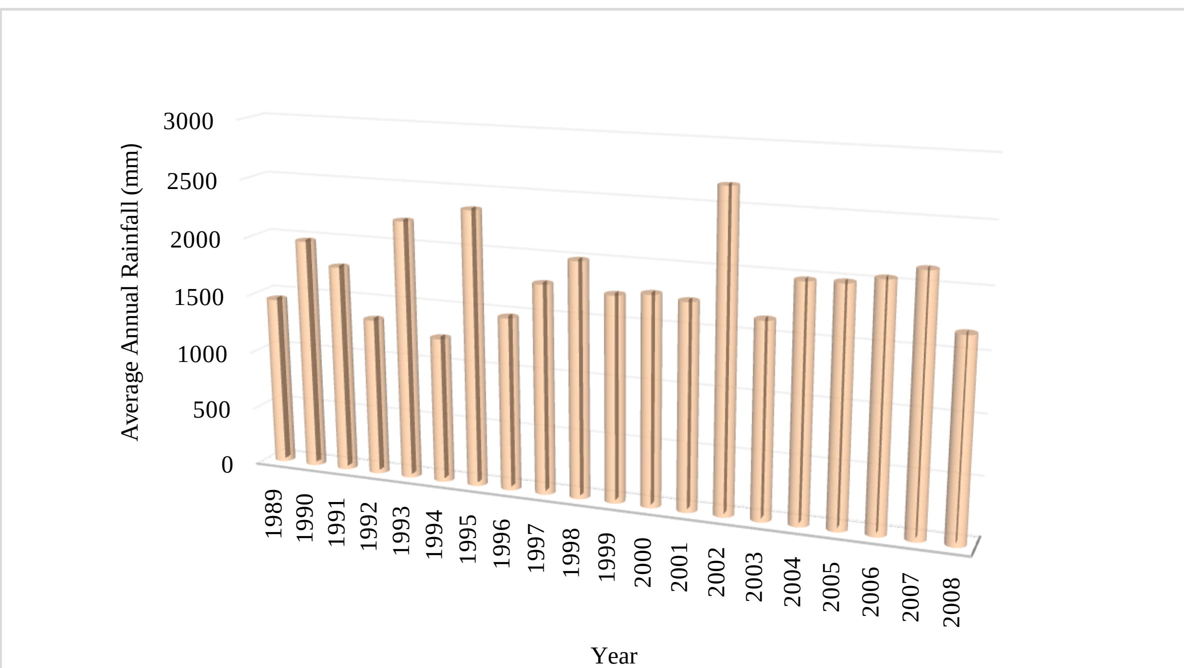

Figure 5: Average yearly rainfall data from 1989 to 2008 (Water Aid, 2012)

CONCLUSION

Cox's Bazar is the main tourist spot in Bangladesh, and with the Rohingya refugee camps around Cox's Bazar, the water scarcity will rise. Groundwater depletion in Cox's Bazar reflects a scenario where massive extraction of water will lead to seawater intrusion into the fresh groundwater bedrock. Rainwater harvesting is a cheap and effective method to cut groundwater dependence and restore the sustainable water supply. More research on water demand and supply will help plan public water and sewerage needs of Cox's Bazar and the refugee camps.

Acknowledgments

The author acknowledges the support received from mentors and friends.

REFERENCES

Ahmed M and Arora, M (2012). 'Suitability of Grey Water Recycling as decentralized alternative water supply option for Integrated Urban Water Management', IOSR Journal of Engineering, 2(9), 31-5.

Bangladesh Meteorological Office (BMO) (2018). Rainfall Data from 1970-2016. Dhaka, Bangladesh. Accessed in June 2019.

Haque MM (2011). Research Paper on Water Harvesting System, Habitat for Humanity International- Bangladesh, Mymensingh, Bangladesh.

Mirdad MA and Palit SK (2017). Investigation of ground water table in the South-East (Chittagong) part of Bangladesh. Chittagong: American Journal of Civil Engineering, 1: 06-07

The California Clean Water Team Guidance Compendium for Watershed Monitoring and Assessment State Water Resources Control Board 5.1.3 FS-(RC) 2011

United Nation Development Program (UNDP). A study: Groundwater levels fall drastically around Rohingya camps: Dhaka, Bangladesh 2019.

WaterAid (2012) Water Security Framework, International Conference on Sustainable use of Water, London, UK, 2: 19-20.

WaterAid Report (2011). Rainwater harvesting for recharging shallow groundwater in Patan, Nepal. www.nepal.wateraid.org

World Bank (2019). Weather data of Bangladesh.