Rainwater Harvesting to Reduce Water and Economic Poverty in Coastal Bangladesh

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Abstract

The economic condition of coastal communities in Bangladesh is adversely affected by the freshwater crisis arising from salinity intrusion in ground and surface water. Even though the country receives 2400mm (average) rainfall per year, the use of rainwater is undermined by the water governance system and by the increasing dependence on contaminated groundwater. Based on this argument, this paper explores how can rainwater be used to reduce the freshwater crisis problem in coastal Bangladesh? This paper focuses on the climate-induced water poverty approach based on fieldwork experiences in Chilla, coastal Bangladesh. The findings indicate that the majority of the population living in Chilla, like many other coastal communities, has been facing severe freshwater poverty which, in turn, makes them economically poorer. It also argues that the promotion of a Rainwater Harvesting System (RHS) alongside a strong governmental financial and technical assistance can reduce water and economic poverty.

Keywords

Climate-induced Water Poverty; Coastal Communities; Freshwater Crisis/poverty; Rainwater Harvesting System; Salinity Intrusion; Water Governance

Introduction

Bangladesh is one of the most vulnerable countries to climate change effect in the present world. Within the country, the coastal region is more vulnerable than the urban region due to its geographical location. The proximity to the Bay of Bengal and the increasing and recurrent nature of the climatic problems like salinity intrusion, cyclones, storm surges, and floods facilitate this vulnerability. As such, the freshwater crisis is a major concern which arises from the salinity intrusion in the coastal region. Besides salinity intrusion, the uninterrupted pollution of surface water sources like rivers, ponds, and canals by industrial and agricultural chemicals, unhygienic activities; the arsenic pollution in groundwater; lowering groundwater level due to excessive withdrawal; and the lack of recharge of aquifers are the main constraints for the development of a dependable freshwater supply infrastructure in Bangladesh (Islam et al., 2015). Since freshwater is conceived as an essential component for the development of any region irrespective of their location, size, and economic capacity, the increasing insufficiency of freshwater supply has made it necessary to rethink the governance and the management pattern of an ecological resource like rainwater in coastal Bangladesh. In this context, academic research is needed for exploring the possibility of Rainwater Harvesting (RH) for reducing the freshwater crisis that might lead to socioeconomic development in the coastal community. This paper answers the following research question: how can rainwater be used to increase the socioeconomic development in coastal Bangladesh?

Presently, freshwater supply sources like ponds, groundwater, canals, and rivers in the coastal areas are not reliable due to the salinity intrusion and the climate change effect. Failure of this freshwater supply largely affects the financial position of the coastal people with increasing health costs and reducing income opportunities. Notwithstanding such facts, the country receives abundant rainwater which is about 2400mm per year (Ghosh et al., 2015). Most of this rainfall occurs during monsoons. The mismanagement of rainwater creates a number of problems like flooding, water stagnation, and damage of agricultural crops and infrastructures. A proper management of this rainwater by RHS can bring two major benefits. Firstly, it can reduce the risk of flooding during monsoons (June to October) and it can mitigate the drought problem during the dry season (October to March). Secondly, it can be a good alternative source of freshwater which can be collected during the monsoon, and preserved and used during the freshwater crisis period especially during the dry season. Additionally, it can improve the financial position of the coastal population by reducing the health expenditure and increasing income opportunities with freshwater supply improvement. For an effective utilization of rainwater, mutual interaction is needed between government organization, non-governmental organizations, and users of ecological resource which has used by Elinor Ostrom (2007) in her Social-Ecological System Framework to bring out a better outcome by managing ecological resources like rainwater.

Literature review

Groundwater is the main water supply source in rural and urban areas of Bangladesh because it is free from pathogenic microorganisms and it is available at shallow aquifers (Islam et al., 2014). However, the process of groundwater uptake makes the country vulnerable to arsenic contamination (Abdullah and Rahman, 2015) and it may be a vital reason for creating a zone of aeration in clayey and peaty sediments which contain arseno-pyrite (Safiuddin and Karim, 2001) that accomplice arsenic contamination in the country. Additionally, for a densely populated area such as the Bagerhat district, where the population and the shrimp farming growth is high, it is not viable to use the groundwater for a long term. Rapid groundwater depletion may result in getting the source polluted with salinity intrusion. The salinity levels of some coastal districts in Bangladesh are displayed in table 1:

Table 1: Salinity presence in surface water in some coastal districts

District	Salinity in surface water in ppm
Bagerhat	5->10
Barguna	1-5
Barisal	0
Bhola	1-10
Patuakhali	1-10
Pirojpur	0-10
Satkhira	5->10
Khulna	5->10

Source: Islam, 2004

Moreover, the coastal region, particularly the southern part of Bangladesh, is a hotspot for climatic problems like salinity intrusion. According to the Asian Development Bank (ADB) Report 2011, the level of salinity has been increasing in the last several years. The report identified that some major factors like the sea level rise, prolonged dry weather, and shrinking groundwater were responsible for this increase. The level of salinity intrusion may increase further for the same reasons in the coming future. The increase of salinity intrusion and the freshwater crisis became severe in the south and the western part of coastal Bangladesh (Islam et al., 2014), and began to affect the socioeconomic development in that region.

In this context, it is important to find a new and viable freshwater supply source for the Bagerhat district. Rainwater is the only renewable and viable source which is easy to collect either individually or socially with a minimum cost (Islam et al., 2014). "RHS requires a collection basin or catchment, usually the roof of the house to harvest rainwater, a piping arrangement and a container to store it" (Islam et al., 2014: 142). Islam et al. (2014) also showed that the cost for RHS is US$171 for 2000-liter storage capacity which is suitable for coastal people with their socioeconomic position.

The longevity of an RHS infrastructure is from 15 to 20 years (Islam, 2017). The collected rainwater can be used for drinking, cooking, and dishwashing purposes (Islam et al., 2010).

The collected rainwater is free from arsenic contamination and it presents acceptable means of freshwater as it meets physical, chemical, and bacteriological quality (Rahman and Jahra, 2006). The collected rainwater is good for health as it is free from arsenic contamination and salinity intrusion. Hunter et al. (2010) found a positive relation between an adequate freshwater supply and health status. This relation has either direct or indirect impacts on health. For example, poor-quality drinking water is one of the main factors responsible for diarrhea (Pruss and Havelaar, 2001; Fewtrell et al., 2005) and "diarrheal disease is the second most common contributor to the disease burden in developing counties" (Hunter et al., 2010: 2) like Bangladesh. RHS may contribute to reduce this diarrhea problem and other water-borne health problems that arise from the lack of freshwater and can contribute to the socio-economic development in the coastal region.

RHS is a strategic measure for socioeconomic development which provides crucial and effective means of poverty alleviating in semiarid regions where freshwater sources are scarce or contaminated (Deng et al., 2004; Zhu et al., 2004). This socioeconomic development can be measured in terms of reducing the health care cost (Hunter et al., 2010), saving time and money, increasing financial savings, and income generating activities. Haller et. al (2007) found that every US$1 investment on water supply and sanitation would provide economic returns of between US$5 and US$46 with the highest return in the least developed countries and most of this additional income comes from saved time by having a reliable water supply near to the household. "A 2012 estimate suggests that cutting just 15 minutes off the walking time to a water source could reduce the mortality of under-five children by 11% and the prevalence of nutrition-depleting diarrhea by 41%" (Harlin et al., 2015). This saved time can be used for income generating activities like running a small business in the household, poultry farming, livestock rearing, producing vegetables in the house yard, and fisheries. Moreover, the investment in water can alleviate poverty (Carter and Bevan, 2008; Hanjra and Gichuki, 2008) by reducing the workload of women and creating income opportunities for them.

The sufficient supply of freshwater near the household can save time that can be spent on productive activities like crop production (Wahal and Harti, 2012) and taking care of their health and children. Safe water supply may provide livelihoods and entrepreneurial opportunities in various areas such as services, constructions, and small businesses for poor people and it can generate high returns for local economies regarding employment creation and multiplier effects (Harlin et al., 2015). Additionally, RHS can contribute to the household income improvement by improving water supply to the household (Hatibu et al., 2006). For example, drinking polluted water causes health-

related problems which might limit employment and income opportunities. Additionally, irrigation from RH is more economical than the forced pumping of groundwater due to the installation and annual operating costs of a pump.

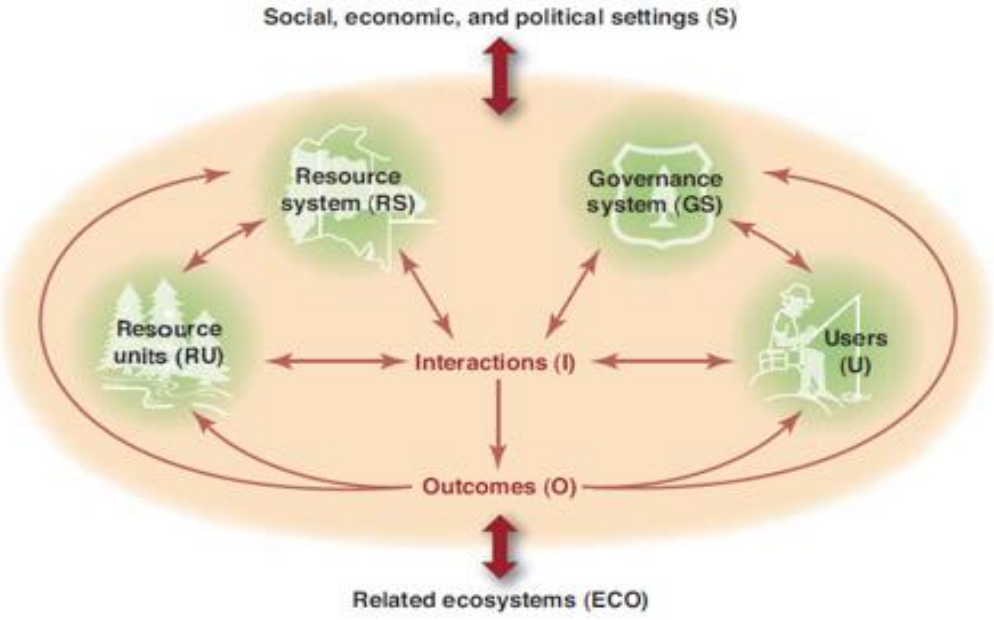
The promotion of RHS must take into consideration the technological, ecological, social, economic, political (Li et al., 2000), quality, and knowledge factors which can be major constraints for its successful application. The lack of knowledge and awareness about the maintenance and operation of RHS, the lack of finance to build up the infrastructure, the lack of space for storage tanks as coastal region is densely populated, and the low mineral salt in collected rainwater might be adversely affected the performance of the system (Abdullah and Rahman, 2015; Islam et al., 2014; Rahman and Jahra, 2006). To add mineral salt with harvested rainwater may increase the cost of using RHS. Moreover, RHS might be an attractive solution for the freshwater crisis from the technical, ecological, and economic perspective, but possible health risks from intake of harvested rainwater related to microbiological and chemical contaminants need to be taken into consideration (Ghosh et al., 2015). Those contaminants have been found in collected rainwater and sometimes they exceed international and national guidelines for safe drinking water (Simmons et al., 2001; Chang et al., 2004; Zhu et al., 2004). Although RHS has some drawbacks, it can play an important role in solving the freshwater crisis in the coastal region in Bangladesh. In order to overcome these drawbacks and getting the full benefits from its application, there an effective interaction among rainwater harvesters, government as well as non-government organizations is needed.

The coastal region of Bangladesh is a part of the Ganges Delta which is intersected by large tidal rivers discharging into the Bay of Bengal (Khan et al., 2011), and the saline front along that coastline has encroached > 100 kilometers inland into ponds, canals, groundwater supplies, and agricultural lands through various estuaries and water inlets, which have connection with the major rivers (Allison et al. 2003; Rahman and Bhattacharya 2006). Salinity encroachment might affect the economic position of the coastal community due to the creation of freshwater crisis. However, the impact of salinity intrusion is dependent not only on their hydrological characteristics but also on management and governance (Silva et al. 2015).

The aim of this article is to analyze how the governance system of ecological resource can reduce economic poverty arising from salinity intrusion. The Social Ecological System (SES) framework of Elinor Ostrom is applied to achieve such goal. Elinor Ostrom's strive "turned to identifying eight underlying design principles that characterized robust common property institutions" (Ostrom, 2005) and provided a framework to analyze SESs (Ostrom, 2007, 2009). "Analysis of how attributes of a resource system, the resource units generated by that, the users of that system, and the governance system jointly affect and are indirectly affected by interactions and

resulting outcomes achieved at a particular time and place" (Ostrom, 2007;15182). The outcome of an ecological resource like rainwater depends on the interaction between these subsystems (shown in figure 1).

Figure 1: The subsystem in SES framework



Source: Ostrom, 2009

Under each of these subsystems there are several multiple second level variables and the framework helps to identify relevant variables for the study (Ostrom, 2009). Ostrom's Government Organization variable (GS1) under Governance System (GS) was selected for this analysis because government organizations are solely responsible for rules and regulation, ecological resource management plans, and find out the solution of problems such as freshwater crisis and economic poverty. Furthermore, the State's utmost priority is to serve the common interest of the people, which was another reason for selecting the governance system. With respect to rainwater, the other subsystems of SES are working well but the lack of governance in rainwater use was the reason for the lack of better outcomes from this ecological resource. These three are the main reasons for limiting the analysis to the governance system.

In Bangladesh, Abdullah and Rahman (2015), Ghosh et al. (2015), Islam et. al (2010), Islam et al. (2014) and Islam et al. (2015) found that RHS is a good alternative to solve water shortage problems in coastal and non-coastal regions but regulatory authorities[6] failed to understand the importance of RH. Additionally, Chan et al., (2016), Chadwick and Datta (2003), Kabir and Das

[6] Ministry of Water Resources (MoWR), Bangladesh Water Development Board (BWDB), Water Resources Planning Organization (WARPO), Joint River Comission (JRC), Water Supply Authority.

(2015), WWF[7] and H & M[8] (2015) analyzed the water sector's policy and acts such as NPSWSS[9] 1998, NWP[10] 1999, GPWM[11] 2000, NWRD[12] 2001, NWMPDS[13] 2011, BWA[14] 2013 but they did not find any policy related to rainwater harvesting. Moreover, within the framework of the Rainwater Harvesting Convention in 2012 participants and organizers urged the Government of Bangladesh (GoB) to include the RH in policies including the National Building Code, National Housing Policy, and other related policies (WaterAid, 2012) but there has not been any visible measure taken (Muyeed and Rahman, 2014). Moreover, the policy does not always reflect the practice and vice versa and there is always a big gap between policy and practice because it is dependent on the execution mechanism of the regulations in place (Kabir and Das, 2015).

Conceptualization and operationalization

Salinity intrusion is the encroachment of saline water into freshwater sources like aquifers, ponds, canals, rivers, estuaries, and groundwater, which can lead to polluting those sources and other consequences. Saltwater intrusion mostly occurs in coastal aquifers because there is a hydraulic connection between groundwater and seawater. It has some characteristics like higher water pressure and mineral content, and it is denser than freshwater which pushes it inland beneath the freshwater (Johnson, 2007). However, the lowering of the groundwater level and the excessive withdrawal from aquifers have increased saltwater intrusion in many coastal districts. Other contributors to saltwater intrusion are climatic problems such as the sea level rise, tidal surges, and cyclones. There are 14,698 sq. km. areas that are highly exposed to the extreme salinity of 1ppt of zero sea level rise (Sarker and Ahmed, 2015). Enhancement of the sea level rise might exacerbate the situation. Most of these saline vulnerable areas are the southern districts of Bangladesh namely Bagerhat (study site), Satkhira, Khulna, Pirojpur, Patuakhali, Barguna, and Bhola as these districts are close to the Bay of Bengal (Islam, 2004). In these areas, saltwater intrusion creates the freshwater crisis, also known as water poverty.

"Access to safe drinking water and sanitation is a human right" (WWAP, 2015). However, this access to safe drinking water and sanitation is unequal in the world, and even within a single country. For instance, the coastal people in Bangladesh suffer more from the freshwater crisis than urban people due to the climate change effect. This shortage of water can be called "Water Poverty"

[7] World Wide Fund for Nature.
[8] Hennes & Mauritz.
[9] National Policy for Safe Water Supply and Sanitation.
[10] National Water Policy.
[11] Guidelines for Participatory Water Management.
[12] National Water Resource Database.
[13] National Water Management Plan: Development Strategy.
[14] Bangladesh Water Act.

and it can be defined as the shortage of safe water to meet water needs in the household, agriculture, and industrial sectors. The Oxford Dictionary defines water poverty as the situation where water sources are inadequate for the access of sufficient safe water to meet one's basic needs.[15] Raskin et al., (1997) measure water scarcity in terms of quantity. Above 1700m^3 annual per capita water supplies indicate that there is little or no water and below 1000m^3 per capita indicates water scarcity that threatens economic development, human health, and wellbeing. Less than 500m^3/capita water supply means absolute water scarcity. This water poverty might produce economic poverty particularly in coastal Bangladesh where people suffer more from freshwater poverty than other regions.

The Economic Poverty (EP) concept is defined in terms of the capability of a person in the economic transaction, such as purchasing consumption items, getting health services, selling productive services, and engaging in productive activities. Money is the main actor of those economic transactions. Money does not come automatically to the people, it requires income opportunities. These opportunities encompass performing in a job or doing business. To perform either of these functions, good health is a prerequisite and it largely depends on the supply of freshwater. For this reason, the freshwater crisis arising from saltwater intrusion is a major concern in coastal Bangladesh, which adversely affects the income opportunities for the locals. As the freshwater problem persists, it might create health problems that can increase medical expenditure. As for the consequences of the freshwater crisis, people face an economic crisis in two ways: they might lose income opportunities due to physical illness and lose financial savings for health expenditures arising from physical illness. Both ways make the coastal people economically poorer as they negatively affect their income or their savings. RH can be a good alternative source of freshwater as the country receives ample rainfall (e.g. 2400mm on an average) every year.

Rainwater Harvesting (RH) is a system of inducing, collecting, storing, using and conserving rainwater either from the roof top or open space for domestic or industrial purposes. RH involves a system of concentrating, storing, and collecting rainwater for agricultural, environmental, domestic, and industrial uses (Sutherland and Fenn, 2000). "Rainwater Harvesting strategies may vary from direct runoff concentrations in the soil for direct uptake by the crops, collection and storage of water in structures (surface, sub-surface tanks, ponds and small dams) and aquifers for future productive uses" (Pachpute et al., 2009: 2816). The volume of rainwater collection and use depends on several factors such as the area where it is taken from, storage capacity, financing of the system, technical know-how of the rainwater harvester, intensity and volume of rainfall, operation, and maintenance of RHS.

[15] See Oxford Dictionary (2018).

The use of rainwater can reduce the freshwater crisis, which might lead to reducing the loss of income opportunities and financial savings. If we consider reduction of medical expenditure due to the use of rainwater rather than polluted water the rainwater has economic value. This value can be quantified in terms of monetary value in medical expenditures, income opportunities, and expenditures for collecting and purchasing freshwater. In order to use the rainwater, it needs operational rules, monitoring and a sanctioning process of rainwater use, financial and technical support. The question is who will take lead in using rainwater and provide the required support for the better outcome from rainwater.

The government is responsible for ensuring the supply of freshwater among the citizens irrespective of their place, socioeconomic position, religion, and other grounds. In a nutshell, the government cannot be biased in supplying freshwater, as it is a basic human right. For ensuring sufficient freshwater in the coastal region, the government can promote the idea of rainwater use for socio-economic development by preparing rules and regulations regarding the rainwater use, create awareness about the benefits of rainwater use, provide technical support like training in maintenance and operation of RHS, and financial support to the poor people for setting rainwater harvesting infrastructure. Yet, the government of Bangladesh relies on groundwater as their main source of freshwater and ignores the importance of rainwater. This kind of water governance approach also helps saltwater intrusion as the over-extraction of groundwater reduces the pressure and lowers groundwater levels, which ultimately makes the people economically poorer.

Materials and Methods

The present study was conducted by collecting qualitative and quantitative information from primary and secondary sources. Primary data were collected by using Focus Group Discussions (FGD), questionnaire surveys, Key Informant Interviews (KII), and participant observation methods. FGD was held before questionnaire surveys for a broader understanding of rainwater harvesting and economic poverty which was helpful for preparing survey questionnaires. After the questionnaire survey, FGD took place to cross-check the collected information. In order to obtain information as in-depth as possible about the relation between water poverty and economic poverty, history of rainwater harvesting practices, government roles, and environmental history, older day laborers, farmers, fishermen, fisherwomen, and two local government officials were selected as Key Informants (KI) who have extensive knowledge about those issues. Random sampling techniques were used to select the participants. Secondary data were gathered from different published and unpublished literature of different scientific research works, seminars, workshops, non-governmental organizations (NGOs), and different ministries and departments in Bangladesh.

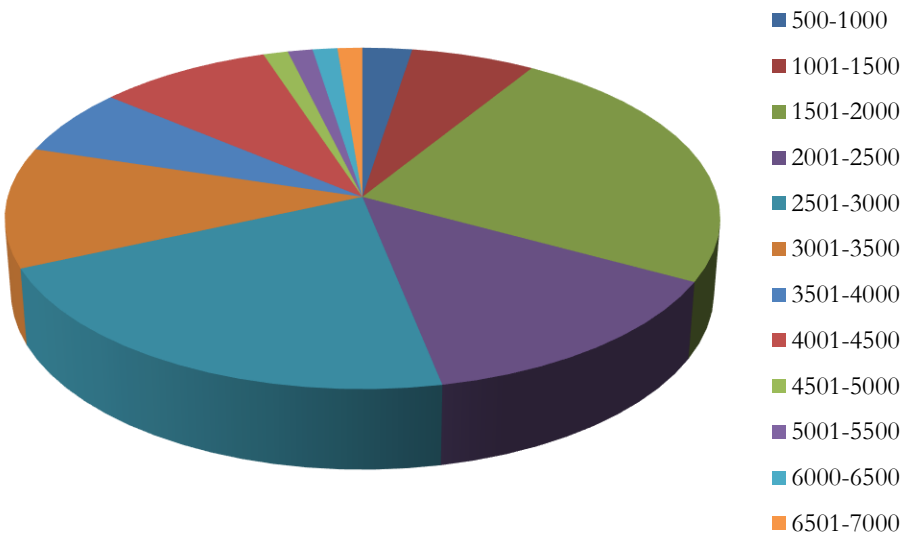
"Methodology is influenced by worldview and the underlying beliefs and attitudes concerning the world we live in, and how we can obtain knowledge about it" (Corbin and Strauss, 2008: 5). In order to obtain the knowledge from the world, this study is multidisciplinary in nature and uses quantitative and qualitative methods of data analysis. After collecting the data, statistical analyses were performed (with SPSS and NVivo). Multidisciplinary research is helpful to combine different disciplines to solve a practical problem, to develop new expertise, and to produce high impact research. At the same time it is very challenging and expensive as it requires combining different directions into one.

Analysis and Findings

Freshwater Crisis and Economic Poverty

The people in the Chilla community rely on five different sources of freshwater for fulfilling their water demand. Such sources are rainwater, groundwater, sweet pond water, river water, and bottled water. Bottled water is very expensive; sweet pond[16] water is far away from the Chilla community; groundwater is polluted with arsenic and saltwater; and river water is saline almost whole year and polluted with agriculture and industrial wastes. In these circumstances, within the study group, everyone in the Chilla community spends money for freshwater supply to their family except for one person who has enough storage capacity to collect rainwater for the whole year.

Figure 2: Expenditure for Water Purchase (in BDT)



Source: Field data, Author

[16] It is a big pond where water is not saline. The water in pond is not affected by saltwater intrusion.

Figure 2 shows that 24% of people usually spend BDT 1501-2000 (US$18.76-25[17]), while 14% of people from the total of respondents spend BDT 1501-2000 (US$ 18.76 – 25) for water purchasing purposes every year. However, 22.50% of people in the study group spend BDT 2501-3000 (US$31.25 – 37.5) for the same purpose. With the accumulation of these three expenditure groups we can cover more than 60% of the total of respondents. Within the study group, nine respondents spend BDT 3001 – 3500 (US$ 37.5 – 43.75) for buying water from either water trader[18] or bottled water. It is noticeable that BDT 4001 – 4500 (US$ 50 – 56.25) was spent for water purchasing purpose by five participants a poor community like Chilla, where 80.5%[19] and 6.3% people live in *kutcha* and *jhupri*[20] house respectively (BBS, 2015). In the same way, five participants spend more than BDT 5000 for water purchase purposes within this study group. In a nutshell, people in Chilla, like any other coastal communities in Bangladesh, spend a good portion of their income for water purchasing purposes. This kind of high expenditure for water is not needed even in most part of Dhaka city, which is one of the most populated cities in the world. This type of practice makes them economically poorer, yet they have no alternative because it is related to their health care which can make their survival more challenging. In order to reduce economic poverty, they need to find out suitable freshwater sources that can supply enough freshwater to the community.

Only one source, rainwater, can contribute to reducing this economic poverty by supplying sufficient freshwater to the community. This possibility of economic poverty reduction can be determined by four economic aspects: health expenditure, income opportunities, financial savings, and saving time.

Health expenditure

The primary purpose of rainwater harvesting is to improve freshwater supply because coastal people have been facing a freshwater crisis problem for a long time. For this freshwater crisis, they suffer water borne diseases such as diarrhea, cholera, dysentery, and typhoid. KI Mohon Bachar could not work for a period of nearly one month during the severe freshwater crisis period[21] last year (2016) because he suffered with diarrhea and stomach pain for around ten days. He spent around 1500 (US$ 18.75) for that treatment. As per his doctor's prescription, the reason behind his illness was polluted water. But he did not face the same kind of problem during rainwater use period.

[17] One US$ equals to BDT 80.
[18] It is a group of people who collect water from a big sweet pond and sale it to the locals. They carry this water from big sweet pond to the local area.
[19] Its floor is built by soil. Generally, if people have money, their floor is made from brick, cement, and sand.
[20] This kind of house is made from polyethylene, bamboo, and bush. It can be damaged with the normal speed of wind.
[21] December 14 – May 13.

According to the questionnaire surveys results, all of the survey respondents (80) believe that their health status improve with the use of rainwater. More specifically, seventy one respondents out of eighty informed that that their diarrhea, dysentery, and stomach pain stopped during the rainwater use period. Opposingly, they face those problems when collecting pond water and when buying pond water. For this reason, their medical expense is higher during pond water than rainwater using period.

Saving time and income opportunities

As the questionnaire survey results show, rainwater harvesting has been creating income opportunities for the respondents by reducing skin problems (16), stomach pain (15), diarrhea (45), dysentery (15), cholera (5), digestion problem (6), and vomiting. As they suffer less physical illnesses, they can perform their jobs properly. These are indirect income opportunities. Arcona Roi and Biswanath Bala informed that they can earn more money during the rainwater use period because they do not need to spend time for collecting water from the distant freshwater source such as the sweet pond. In a single time water collection, they need to spend almost the whole day for collecting and carrying water from the freshwater source. Moreover, this water collection is not free of charge, as they cannot carry water by themselves because of the distance[22]. They have to rent a transporter[23] to go to the water source and carry the water. They can use this saved time to work as a laborer in the river or in the fishing farm.

Financial Savings

This study covered eighty households in the Chilla village in Bagerhat district in Bangladesh. All the respondents gave a positive response about financial savings with RHS. It is either direct or indirect. For instance, eighty respondents think that their freshwater supply has improved by RH, which contributes to their physical fitness. This physical fitness enables them to perform their professional responsibility properly so that their income is not hampered by physical illness. Shohor Banu, Arcona Roi, and Mohon Bachar told that their average water expenditure is BDT[24] 3000 (US$ 37.5) for eight months. Through the remaining four months of the year they use rainwater for freshwater purposes. If they do not collect rainwater, their expenditure will increase to BDT 4200 - 4500 (US$ 52.5-56.25). They save BDT 1200 – 1500 (US$ 15-18.75) each year with their current storage capacity. However, if they have enough storage capacity they do not need to spend money for water purchase because they can collect enough rainwater for the whole year. Moreover, if they have training about the process of collecting, reservation, and use of rainwater they could use their

[22] The shortest distance is 4 miles.
[23] Trawler (a kind of big boat run by engine) or boat, van, or small truck.
[24] BDT=Bangladeshi Taka. One US$ = BDT 80.

collected rainwater more efficiently, which might expand the period of rainwater use due to improving efficiency.

Discussion

In order to get the full benefits from rainwater, the coastal people need substantial support from the government of Bangladesh in policy formulation, increasing technical capacity with training, increasing awareness about rainwater use, and finance or storage tank. Let us see how the government has been playing its role regarding rainwater use in those aspects.

A government is a "conduct of conduct," the way some look for to act upon the behavior of others to alter or channel that behavior in the specific direction (Foucault, 1982: 220-221). The government is responsible for the wellbeing of their citizens by any means. Here, 'means' indicate policy. The policy is the way to ensure a disciplined usage of any kind of natural resources including rainwater. As the other sources of water are not viable for the coastal community, the government needs to prepare a policy to use this resource to supplement the existing water supply system and to bring discipline in its use. Otherwise, it will hamper the groundwater and surface water interaction, which is important for the ecosystem and biodiversity. For instance, rainwater helps to recharge the aquifers[25] through infiltration. The aquifers need to recharge as the people pump out water from it. If all rainwater is collected and used then the aquifers will not recharge, which will cause salinity intrusion further inland and expand arsenic contamination areas. It is unfortunate that, as per the survey in Chilla, they do not need any kind of permission to set up an RH infrastructure in the household or in the industry. Moreover, they do not have any obligation to use rainwater for meeting their freshwater demand. Therefore, it is assumable that there is no such kind of policy existing in Bangladesh.

The interaction between the coastal community and the government is an important aspect for the governance system and to address the problem (e.g. water poverty). Most of the people in the coastal region are poor and largely rely on the government to sort out their problems. But they are continuously facing challenges with respect to access to government services due to lack of officers, lack of technical knowledge of the concern officer, nepotism, and corruption. Mohon Bachar informed that he did not get relief in 2009[26] and 2016[27] because of nepotism and corruption. In 2015, he tried to get advice from the government office for placing the storage tank to collect rainwater but failed because he could not provide the demanded bribe. Additionally, Arcona Roi informed that she did not get water purification tablet in 2007.[28]. She does not know why. The

[25] Aquifers are large storehouse of water under the surface.
[26] After cyclone Sidr.
[27] After floods.
[28] After cyclone Aila.

concern officer told her that the tablets were not available anymore, but she saw that the other people[29] were getting tablets. KI Bahadur Mia[30] (fake name) informed that most of the time he provides services to either rich or politically affiliated individuals because the former can give money and the latter can help him to get extra benefits (e.g. promotion, getting transferred from Mongla to Dhaka). The other KI acknowledged the problems but they are trying to improve the situation.

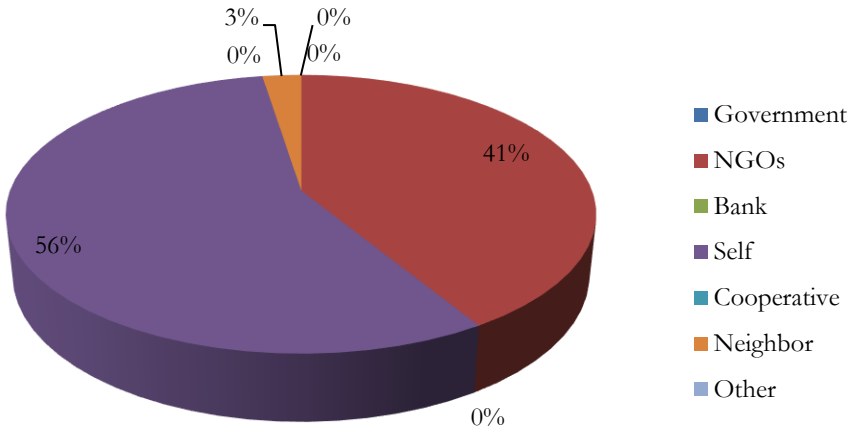
A rainwater harvesting system might be simple to operate and maintain. In order to obtain the full potential benefits from collected rainwater, the technical knowhow for a long-term use as well as the maintenance of good quality of the collected rainwater are a necessity. Without technical knowledge, sometimes collected rainwater cannot meet the demand of freshwater as it can affect the quality of collected rainwater. Mohon Bachar, a KI, informed that he could not use the collected rainwater for the expected long time because of pollution a few years ago. He had collected rainwater in October and started to use it in mid-November. After using it for nearly one month it seemed to him that there was a bad smell in the collected rainwater. Subsequently, he checked the storage tank of collected rainwater and his concern was confirmed. He threw out all of the collected water. As a result, he faced a severe freshwater crisis and had to spend a lot of money for water purchase purpose that year. The technical know-how can be developed by training the rainwater harvester[31] in the procedure of rainwater collection, cleaning the rooftop[32] (catchment area), cleaning the storage tank, the location of the storage tank, and keeping the collected rainwater safe from pollution. According to the survey, the government does not provide training for the Chilla people. However, some NGOs such as Tearfund UK, Prodipon, Sushilon, BRAC, World Vision, Concern Worldwide, provide training to the community.

Rainwater harvesting might be a good alternative to resolve the freshwater crisis in the coastal region where existing freshwater supply source failed to meet up the demand for freshwater. For effective utilization of the rainwater, the people need to know about the system, advantages, disadvantages, and technique of collection and use of rainwater. In this circumstance, an awareness-raising campaign can play an important role in create awareness among the people in Chilla. According to the questionnaire survey, 48.75% of total participants informed that they did not notice any awareness campaign held in Chilla. It may be held but without these locals having been informed about it. On the other hand, 51.25% of all respondents informed that an awareness-raising campaign was indeed held in Chilla and they participated at an event related to it. This awareness-raising campaign was arranged by various NGOs like World Vision, Rupantor, Prodipon, Hit Bangladesh,

[29] Who has a good relation to the officer.
[30] A government officer in Mongla and Key Informant. Fake name because he/she doesn't want to expose his/her identity.
[31] The one who collects, preserves, and uses rainwater.
[32] From where rainwater can be collected

Concern Worldwide, Tearfund UK, and BRAC. The activities of awareness-raising campaign include rally, house yard meeting, and talking to the locals.

Figure 3: Finance for Rainwater Harvesting System in Chilla



Source: Field Data, Author

Thirty three (41.25% of total respondents) people get finance from NGOs (shown in figure 3). This type of finance came either through a large tank or from a monetary benefit such as lending. The lending came from the Association for Social Advancement (ASA).[33] Within this NGOs beneficiary group, two persons got finance from ASA and the remaining thirty one respondents got benefits through rainwater harvesting storage tanks and materials from six different NGOs such as Tearfund UK, World Vision, Sushilon, Prodipon, Concern Worldwide, and Rupantor. Within those having received storage tanks and other materials from different NGOs, World Vision provides nineteen large tanks and other materials for rainwater harvesting in Chilla. After World Vision, Concern Worldwide provides five tanks and Prodipon, Tearfund United Kingdom, and Rupantor provides two tanks each of them within the study group in Chilla. In the study group, forty five respondents finance their RHS with their own money and the other two respondents got help from their neighbor regarding finance. Neither government nor formal financial institutions like banks finance RHS. Additionally, NGOs such as ASA do not lend money for rainwater harvesting purposes. The borrowers received the loan from ASA by showing another purpose on the loan documents. For instance, Kamal (fake name)[34] took loan of BDT 20000 from ASA for small business purposes. However, the major portion of his loan was spent for buying large storage tank and other materials for his RHS.

[33] Is a microcredit organization. It is also known as an NGO.
[34] Because he does not want to expose his identity. The reason behind this is that he used his loan for different purpose other than mentioned in his loan application and it can create problems for him.

Conclusion

The coastal areas in Bangladesh are vulnerable to climate-induced problems like salinity intrusion. The saltwater intrusion can create different types of problems. The freshwater crisis is one of them in that region. However, the water sources that are polluted by human intervention, mismanagement of rainwater, and lack of coordination among government, NGOs and the locals trigger a severe freshwater crisis. Consequently, the local communities may lose income opportunities and savings due to their illness arising from lack of freshwater. Moreover, many people cannot irrigate their land and face challenges in home vegetable gardening due to the lack of freshwater. These types of problems make the coastal people economically poorer.

Water is an indispensable part of life. It is not possible to lead a healthy life without freshwater. Every citizen has the right to have access to sufficient freshwater for a healthy and sustainable living. It is the responsibility of the government to guarantee this right. As the existing sources of water cannot fulfil the demand of freshwater at coastal areas in Bangladesh, rainwater can be a good alternative source as the country receives abundant rainfall every year. Additionally, locals use that source for solving their freshwater crisis. However, they cannot use it effectively due to lack of financing, rules and regulations, technical know-how, and awareness. Therefore, effective steps should be taken by the government to promote a rainwater harvesting system in order to solve the freshwater crisis. This way, it may help improve the economic strength of the local population. In this process, the government can invite different NGOs that are working with the same issue in the same region as well as the locals to the table in order to find solutions. For a successful resolution of the freshwater crisis through rainwater harvesting, mutual interaction among government organization, NGOs, and the locals is necessary.

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