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Anatomy of a failure: *Community Adaptation of the Water Purification Method in Coastal Bangladesh*

Syed Ashik–E–Elahi[1] and Khondoker Mokaddem Hossain, PhD[2]

Abstract

Saline water intrusion is not always an usual occurrence and increasing threat for providing safe drinking water in the coastal areas of many developing countries including Bangladesh. Though several attempts like – Pond Sand Filter, Sono Filter, Pond Water Harvesting, Rain Water Harvesting, and other water purification methods were taken to meet the need of adequate safe drinking water for the coastal inhabitants, but so many real-life barriers made all efforts a failure attempt to meet the crisis. In this paper, we have tried to show why a promising, easy to access and comparatively less expensive water purification method, namely Pond Sand Filter (PSF) method failed to run in the local communities. The findings of this paper will help a researcher or policy formulator to get ideas regarding the existing hurdles of establishing such methods in the coastal areas of Bangladesh. There are so many available techniques to meet the need of this crisis, but most of those were failed to be functional at the end. The reason mostly is, those initiators have failed to understand the traditions and customs of the local inhabitants. The findings of this paper will let different thinkers and agencies understand some real-life socio-cultural barriers for which such promising initiatives went in vain most of the times. The research followed the triangulation of quantitative and qualitative method. The quantitative data were collected through sample survey, while the qualitative method followed the FGD and KII. We did conduct face-to-face interview with the representatives of different sectors irrespective to their role in this approach. Moreover, we have covered five specific key informant interviews to understand the problem more intensely. In addition, we have conducted two focus group discussions.

Keywords: Saline water, PSF, Custom, Tradition, Socio-economic condition, Sustainability, Feasibility

[1] *Assistant Professor, Department of Sociology, University of Barishal and PhD Fellow, Bangladesh University of Professionals (BUP)*

[2] *Founder Director & Professor, Institute of Disaster Management and Vulnerability Studies, Dhaka University*

1. Introduction

Scarcity of safe drinking water is a common trend for the coastal areas of Bangladesh. It is usually narrated that salinity in the coastal water bodies is a result of natural process. But in reality, there are so many unplanned development projects which are directly contaminating natural water bodies. To combat the crises of safe drinking water several government, Non-government and local level initiatives have been taken in coastal areas of Bangladesh. But due to negligence every time such initiatives fail to meet the need of the sufferer inhabitants of coastal area.

Nicholls (2007) mentioned that we can understand the severity of water crisis. The availability of fresh and safe drinking water is considered to be the most critical issue in the south-western coastal areas of Bangladesh. In this region the scarcity of drinking water is acute as the fresh water aquifers at reasonable depths are not available and surface water is highly saline. Saline intrusion from sea water owing to reduction of freshwater flow from upstream is expected to be aggravated by climate change and sea-level rises. Government of Bangladesh (1999) observed that salinity in coastal area has already had adverse effects on crop productivity and grain production. Now it appears to be a looming threat to the wellbeing of communities who live in the saline prone coastal areas of this low-lying nation. Islam (2010) mentioned that the arsenic contamination of shallow groundwater has become a major public health problem in many places including the south-western coastal belt of Bangladesh. In this coastal belt the groundwater is often contaminated with arsenic while the surface water is full of salt. The situation is acute in almost all upazilas (sub-districts) of Satkhira, Khulna and Bagerhat district. Upstream rivers such as the Ganges and Brahmaputra are struggling to wash the saline water back out to sea because their currents are getting weaker and often stop altogether in the dry season. The situation has further become worse with the introduction of commercial shrimp farming and the consequent intrusion of brackish water far inside the coast. Sikder (2010) observed that the small tube well has historically been the most common source of drinking water in the rural areas of Bangladesh. These tube wells have been installed at various depths, depending on availability and level of groundwater. However, in the rural coastal areas the development of dependable water supply system through tube wells has been very limited since the fresh water aquifers at reasonable depths are not available and surface water is highly saline and turbid. Even the deep aquifer is often considered to be under high risk of being mined or becoming infiltrated with salt or arsenic contaminated water. Haque (1998) showed that a number of scientific studies identified high concentration of iron and presence of salinity in some existing tube-wells in coastal areas. Farhana (2011) observed that different studies identified a number of socio-economic and technological flaws that hinders the sustainability of these low-cost alternative technologies.

For example, these options often require too much care, discharge small volumes of water, require frequent technical input and maintenance, and sometimes discharge poor-quality water. On top of these, the recurrent cyclone and storm surge have become one of the major threats to the viability of these water supply systems. Recent studies reported that such water supply technologies as pond sand filter have become adversely affected after the two recent devastating cyclones - Sidr in 2007 and Aila in 2009 and the consequential tidal surges. Basar (2012) posited that it has been reported that many surface water sources were submerged by the tidal surge of over 20 feet whipped up by cyclone Sidr in 2007. As a consequence, ponds and wells that provided the main source of drinking water were left salty and contaminated.

Kundu et al. (2016) described that the critical evaluation of the social, economic, environmental and technical performance of the Sono filter by policy actors, international donors, and experts resulted in diverging expectations over whether it could contribute significantly to solving the arsenic crisis. Such diverging expectations (between producers and disseminators of the technology) resulted from issues such as its high cost, short life span, troublesome maintenance, lack of monitoring, unwillingness of users to pay, and lack of agreement on arsenic sludge removal, etc. This non-convergence of expectations between MSUK and hybrid actors (donors, governmental agencies, NGOs and users) hampered niche formation, as project funding became increasingly restricted, the priority of mitigating arsenic crisis had been shifted and no market strategy was available. Rahman (2009) stated that the availability of freshwater will be reduced by increased intrusion of salinity into fresh water sources during the low flow conditions. In the coastal regions this is brought about by sea level rise resulting in saline water intrusion in the estuaries and into the groundwater. The effects are exacerbated by greater evaporation of freshwater as temperatures increase, coupled with a greater demand for fresh water in times of water stress. GoB (2013) observed that development of community resilience in coastal areas of Bangladesh is presently impeded by a range of non-climatic factors. On the one hand, vulnerability has increased due to anthropogenic activities, particularly due to massive conversion of mangroves into commercial shrimp farms, salt pans and increased demand for fuel-wood (e.g. where mangroves are exploited for fisheries), which has reduced mangrove cover that otherwise functions as a natural protective barrier to coastline erosion and inundation. Haque (2006) described that to mitigate the destitute circumstances, the government policy promoted the use of alternative water supply options. The alternative technologies mainly include: i) arsenic-safe improved dug well, arsenic-safe shallow and deep hand tube wells and small-scale piped water supply systems from safe ground water sources, ii) pond sand filter and large-scale surface water treatment plants from surface water sources, and iii) rainwater harvesting systems.

Of the promoted options, low cost household and community-based rainwater harvesting systems (RWHs) and pond sand filters (PSFs) are the most common viable options in the coastal areas. Huq (2017) mentioned that international bodies' attention to environmental issues came as the global climate change is one of the most significant environmental issues of the present world. The problem of this human-induced climate change first came to the attention of the global public and international policy makers when the Intergovernmental Panel on Climate Change (IPCC) published its first assessment report in 1990. Dasgupta (2017) observed that even in the best future case, the livelihoods of 2.9 million poor and 1.7 million extremely poor would be adversely affected by increasing salinity of river water. In the worst future case for salinity incursion considered, there will be adverse impacts on 5.2 million poor and 3.2 million extremely poor people. This means that river water will no longer be usable for agriculture in Barguna, Bhola, Jhalokati, Khulna, and Patuakhali districts in the worst-case scenario. This means that river water will no longer be usable for agriculture in Barguna, Bhola, Jhalokati, Khulna, and Patuakhali districts in the worst-case scenario. Ministry of Forestry (2010) stated that importance notified as non-structural mitigation measures such as policy, management plans, community disaster preparedness training advocacy and public awareness must be given a high priority; this would require an integration of structural mitigation with non-structural measures. WaterAid (2006) described that Pond Sand Filter (PSF) is an alternative and popular option of potable water supply technology in saline and arsenic prone areas in developing countries. It is a package type slow sand filter unit developed to treat surface water, usually pond water for domestic water supply. Slow sand filter is installed near or on the bank of pond, which usually does not dry up in the arid season. The water from the pond is pumped by a manually operated hand tube well to feed the filter bed, which is raised from ground, and the treated water is collected through tap(s). After the test it has been founded that the treated water from a PSF is usually bacteriologically safe or within tolerable limits. Farhana (2011) mentioned that in Bangladesh numerous PSFs have been constructed in the coastal belt by governmental agencies, NGOs, donor agencies, and local communities. The failure in sustainable use of PSFs in developing countries is attributed to a set of socio-organizational problems. These include: irregular maintenance and negligence to maintain the technology, lack of support services, lack of capacity building among community beneficiaries, lack of community ownership and adverse impacts of cyclone induced flooding.

From above literature reviews, it is observed that mainly three types of water purification method have been applied in the coastal areas for ensuring safe drinking and household necessity water. Namely these are - Desalination Plant, Rainwater Harvesting (RWH) and Pond Sand Filter (PSF). In this research I have focused on the

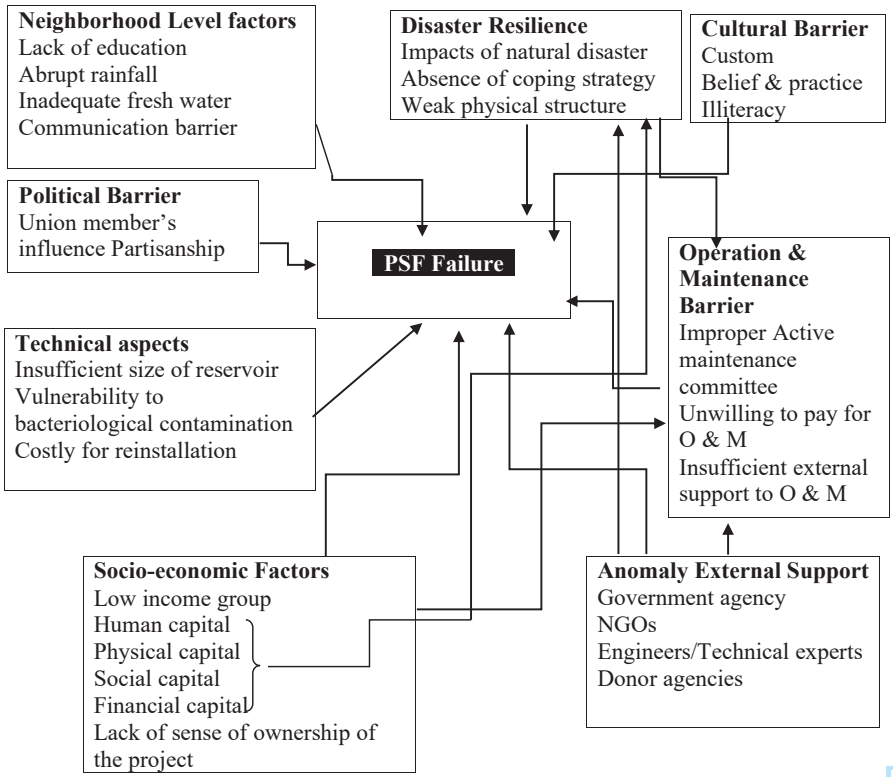
impact of PSF method and its prevailing situation in the community level. In addition, it is worth mentioning that several natural disasters, custom and anthropogenic derogative activities are responsible for the acute drinking water crisis in coastal areas of Bangladesh. So, in this research I will also focus on the susceptible factors behind the failure of coastal water purification projects.

After all, by getting through the literatures and initial visit to the target area of study, we have focused on three specific intervening factors mentioned below.

- to identify various abandon factors affecting easy access of the water purification plant in coastal areas of Bangladesh;
- to recognize the sociocultural and political barriers for implementing different methods to ensure safe water;
- to address the negligible areas in establishing such project during the policy making and implementation.

2. Conceptual Framework

Figure: Conceptual framework of abandon factors behind the failure of an easy to access water purification method in coastal Bangladesh



Above figure shows different meddlesome issues which we have found in our study those are affecting the successful implementation of a water purification method in coastal areas of Bangladesh. Among other issues more erratic factors are lack of enough surface water around the year, negligence, partisanship, lack of maintenance and abrupt installation. Another alarming issue is unconscious behavior and practice among community people. More importantly we have observed that poor coordination during the decision making creating the founder pillar of failure of such projects.

3. Methodology

Initially we conceptualized different aspects and framing the research with the help of the secondary sources. A conceptual framework has been developed to guide the research work on the basis of reviewing existing literatures and primary field observations. To justify the objectives of the study we had followed both qualitative and quantitative research methods. For getting necessary data we have applied key informant interview (KII) and focus group discussion (FGD) techniques as per qualitative method of data collection. In addition, we have conducted a survey based on structured questionnaire following purposive sampling according to quantitative method of data collection. To obtain necessary outcome from survey data we have administered SPSS software which provided us processed upshot for specific narration. In addition to rectify data relevance we have run chi-square test and to justify the validity of variables we have run ANOVA test. Moreover, form collected primary data we have processed some other SPSS output to validate our research more intensively.

4. Discussion and Findings

This paper commenced with the assumption that despite easy access method of water purification system in coastal Bangladesh, the Pond Sand Filter (PSF) system became dysfunctional within a few months of installation. Different socio-cultural and economic barriers noticed right after starting of the project. Among the barriers most significant are negligence in decision making, construction cost, poor maintenance, cultural lack and reluctance to pay for minimum repair charge.

We can assume feasibility of a PSF water-treatment system from the comparison below.

Table 01: Advantages and disadvantages of Pond Sand Filter (PSF) System

Advantages	Disadvantages
Feasible construction Construction of PSF systems is simple and local Mason can easily be trained up to build it.	**Investment costs** The cost of PSF system is almost fully funded by the government or other sources during initial construction. Cost mostly depends on the size of reservoir.
Easy maintenance Operation and maintenance of a plant is controlled solely by simply instructed community people. As such, this is a good alternative to poor maintenance and monitoring of a centralized tapped water supply.	**Regular maintenance** A PSF system can easily be maintained by regular monitoring, maintenance and cleaning which is easily manageable by the facility taking inhabitants.
Relatively safe water quality PSF is better than other available or traditional sources (groundwater somewhat unusable mostly for salinity or arsenic).	**Water quality is exposed** Water quality may be affected by nearby irrigation waste, animal or bird droppings, insects, dirt and organic matter as pond is the main source of water.
Little environmental impact Pond water is a renewable resource and no damage is done to the environment.	**Supply is susceptible to droughts** Occurrence of long dry spells and droughts can cause water supply crisis.
Handiness at household level It provides water at the nearby point of consumption of the domestic.	**Inadequate supply** The supply is limited by the amount of rainwater and the volume of the catchment pond and storage tank.

From chi-square test, we can assume the significance of such water purification projects in community level in coastal areas.

Table 02: Chi-Square Tests

Test	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	200.857[a]	16	.000
N of Valid Cases	76		

a. 18 cells (72.0%) have expected count less than 5. The minimum expected count is .21.

We know chi-square test result gives us the significant relation among different variables. As per output of Table – 2 chi-square test result shows significant relationship among variables (where source of money is dependent variable and rest others such as Government, N.G.O, N.G.O and Beneficiaries, Government and Beneficiaries, Household are independent variables). Therefore, we can say that the hypothesis of the research and factors affecting the dependent variables are strongly associated. So, abandon factors which are considered in the conceptual framework are needed to think about with importance. As a result, in future study these issues should consider with priority.

Case 1:

[Mr. Debproshad Das, Pharmacist, Maa Drug House, Sardar Mor, Koera, Khulna]
Mr. Das is continuing his current business for about last fifteen years. His medicine pharmacy is just beside the *sarder pukur par* in Koyra Upazilla of Khulna district and he is working in this project as a community leader. He has said that the adjacent pond to the project is historically valuable as for the last few decades local inhabitants depend on this pond for drinking water and other household cleaning, washing and bathing purposes. From his long experience he also added that this pond is the only source of safe drinking water for the local community and people from about 1-mile (1.6 km) distance usually collect daily drinking water from here as it is the only source of fresh water in this locality. He further added more than half of the residence of this community is living under poverty level. So, it is quite impossible for them to pay a single penny for collecting fresh water whereas they have to expense most of the income for managing daily food intake. He has mentioned that on the bank of *sarder pukur* government agency has installed two Pond Sand Filter (PSF) units to ensure safe drinking water for the community. But due to lack of maintenance the project went out of service right after about two years of operation. As per his information initially local leader (Member of Union Parishad) takes the responsibility to look after it but after few months he became careless regarding the maintenance matter as there was no one for monitoring the project. From the perspective of sustainability of the project he said with minimum maintenance it could be run for twenty to thirty years as it is sand and brick built. He also said the water source is quite safe from disaster because the pond is well protected by high bank. He shared that people are not cautious about the health safety. Due to pollute drinking water, water borne diseases are very much common among the inhabitants especially the children are the most vulnerable victims. As per his experience he claimed that several projects have been taken by GO's and NGO's to ensure fresh water for the locality but all those initiatives went in vain for the lack of awareness of the community and maintenance negligence of the stakeholders.

Table 03: First initiator of the project * Source of fund Cross tabulation

Categories		Source of fund					Total
		Government	N.G.O	N.G.O. and Beneficiaries	Government and Beneficiaries	Family	
First initiator of the project	Local community	0	0	4	0	0	4
	N.G.O	0	0	8	0	0	8
	Government	4	0	0	0	0	4
	Family members	0	0	4	0	24	28
	Local Govt. Authority	0	20	0	12	0	32
Total		**4**	**20**	**16**	**12**	**24**	**76**

According to Table 3 - result, we can assume that local community people has very insignificant role to take any such initiatives which is only 5.3%, whereas the contribution of the local government authority is the highest as data shows it is 42.1% of the total installments irrespective to different sources of installation fund. On the other hand, sources from family members and N.G.O support shows respectively 36.8% and 10.5%.

Case 2:

[Sobita Rani, Housewife, Sen Para, Amadi, Paikgacha, Khulna]

Mrs. Rani is a traditional housewife. Her daily life is very simple. She mainly has to perform different household activities like – child bearing and nursing, making food for family members, keeping home in an order by cleaning and rearranging different household materials. According to her statements she does not face any major trouble for maintaining her daily life except fresh water crisis. She has mentioned that to collect the daily drinking water she had to go about 2 kilometers away from home. Because though they have a tube well nearby her house but due to salinity water is not potable. As per her observation different governmental and N.G.O agencies took some initiatives to solve the water crisis issue but the lack of proper monitoring and post maintenance support all efforts have gone in vain every time. She sorrowfully claimed that only for collecting potable water she had to spend about 2 hours daily which is really hampers her daily activities especially the child care. When I have asked her about peoples' consciousness, she claimed that most of the people are ignorant regarding the water safety and most of them are reluctant or unable to pay for collecting water.

Table 04: ANOVA[a]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	8.926	1	8.926	68.807	.000[b]
Total	18.526	75			

a. Dependent Variable: Drinking Water b. Predictors: (Constant), Source of money

Analysis of variance (ANOVA) result gives us very complex result on the basis of mean calculation of individual variable. As per Table 4 - ANOVA result gives us very complex result on the basis of mean calculation of individual variable. Above table shows the regression result is significant. So, the variables in this research are strongly valid to verify that abandon factors are strongly relevant to the failure of such safe drinking water supply project.

Table 05: Availability of rain water

Sufficient rain water for the project	Frequency	Percent
No	76	100.0

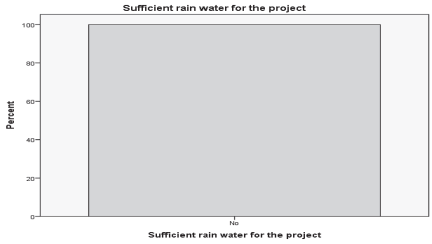


Table 5 - illustrates an alarming result as 100% of the respondents replied that for supporting the prevailing methods of securing safe drinking water there are scarcity of rain water. It is clear from the data that as the coastal water sources are mostly polluted by intrusion of saline water, the community depended mostly on rain water preservation. In addition, scarcity of rain water is responsible for the shortage of surface water.

Table 06: Community role in water supply project

Role in Water Supply Project	Frequency	Percent
Consumer	64	84.2
Supervising	12	15.8
Total	76	100.0

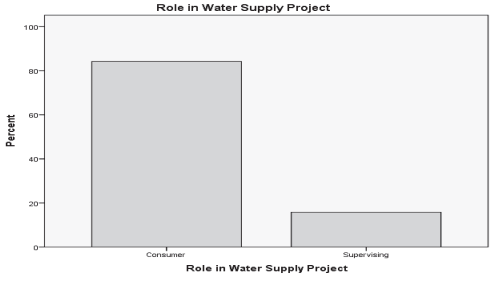


Table 6 - highlights the role of respondents of this research in water supply project. Surprisingly the result shows 84.2% respondents participated as a beneficiary whereas only 15.8% involved in such endeavors as different supervising roles. In this case it is suggested to enhance the participation of beneficiary group in supervision and monitoring activities for more sustainable usefulness of this water supply project.

At the time of collecting data we came across different classes of people and it is found that local people are not conscious enough about safe drinking water. In a tea stall at Baka union we have conducted a Focus Group Discussion (FGD) with a group of people to justify the reality of consciousness among the local people. After a long discussion we came to understand that most people do not pay serious attention to the uses and effects of safe drinking water. Even some of them are preferred nearby surface sources for collecting drinking water than moving to a short distance PSF plant.

5. Conclusion

In this paper the researchers have focused with focusing the abandon factors behind the failure of an easy to access water purification method namely Pond Sand Filter (PSF) and during the study we have found that socio-cultural factors seem vital causes than the physical factors of the project. In a statement Dr. Mohammad Yunus stated that 'Geography is not the main culprit to face disaster rather it is poverty which is liable for the adverse situation'. In our study it is clear that poverty is not the only factor to maintain a safe livelihood rather awareness is also necessary to maintain a healthy living. Though different community activities are in action but most are failed due to the lack of public awareness. It is recommended to prepare long-term water supply strategy and it is necessary to identify all present vulnerabilities and future opportunities, adjusting priorities and understanding cultural barriers before installing any such projects.

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