Performance of existing community-based water supply system in Arsenic affected rural areas (Chowgacha Upazilla) in Jessore District, Bangladesh.

Abstract:

Water Supply Phenomena has become a comprehensive health-based risk assessment and risk management approach to optimizing drinking-water supply from catchments to consumer. The maintenance of good water quality is one of the priority issues of our environment and requires an integrated approach to understand and solve key problems in areas where the social dimensions are larger and suffer from water-related problem. Aspiration of the study was to explore social acceptance, operation and maintenance of existing water supply system to implement arsenic mitigation approaches that includes both technical and socio-economic strategies. For this reason, the Chowgacha Upazilla which is under Jessore district in Bangladesh was used as a model for investigating the present status of water supply system. The study was conducted at four specific arsenic affected villages (Kustia-Ajmatpur, Phulsara-Arardha, and Dashpakhia) respectively. Keeping touch with the problem, various types of water supply options such as Dug-well Sand Filter (DSF), Pond Sand Filter (PSF) and Pipeline Water Supply System (PWSS) had been installed for providing safe water for the welfare of the affected people. Firstly, the data were collected during November to February, 2012 to fulfill my study. Secondly, all water samples were collected from its raw water and filtrate (supply water) to get a view of water quality status at the consumer point. Thirdly, primary data were collected directly from the respondents whereas secondary data were collected from different records available at AAN office, internet and journals. In addition, from this study revealed that Dug well and Pond sand filter water were used by 58% and 31% respondents whereas minority of the respondents use other sources. On the other hand, 2% respondents used shallow tube well water and 9% respondents used pond water for their cooking. Furthermore, it revealed that the microbial contamination of the water was being enhanced due to its improper maintenance. Some percentage of all of the alternative safe water supply options having a good chlorination system, which provides safe water for the people. Another crucial point is that the health condition of consumer is fairy understood among the residents.

Keywords: Arsenic contamination, water supply, Situation, Analysis, Sanitary integrity, Bangladesh.

1. INTRODUCTION:

Water supply renders an inevitable role for the maintenance of the existence of the people's life. In this matter, good water quality is mandatory for ensuring the good health condition of the people. It is a matter of great sorrow that the quality of water supply is deteriorating day by day among the rural areas. To meet the water-supply demand from a surface sources such as a river, lake, impounding reservoir, canal or from an underground source such as a well or spring must be properly provided (Kamala, A and Kanth Rao, D L, 2001)**.** The process of water supply implementation in Bangladesh needs to be successfully done especially in rural water supplies. The inhabitants of the rural areas mainly depends on the surface water which has low arsenic contamination but suffer from acute bacterial contamination and can cause severe health problems if not treated. It is a matter of great regret that with the passage of time, its convenient way to use water has become threatened due to the entrance of the arsenic contamination in groundwater which ultimately reaches surface water due to natural and anthropogenic intervention. The water supply sector in Bangladesh has taken effective steps to overcome the water-related health problem. It has been found from the survey or research report that 29 million people among total population of Bangladesh are exposed to arsenic contamination about 50µg/l that exceeds Bangladesh drinking water quality standards and 10µg/l exceeds the WHO standard level. In order to ensure safe water supply, sustainable plans has to be utilized effectively in Bangladesh (WHO, 2004; Davison et al., 2005). This study consolidates the experience of the development of 'model' water supply system for key rural water supply technologies for implementing effectively in communities by NGOs and the Department of Public Health Engineering (DPHE). Numerous types of NGOs and DPHE have undertaken pilot projects to implement water supply system in remote areas for alleviating their water supply problems. In addition, it will be very effective and will helped planners, implementers and policy makers in understanding the importance of WSPs and steps required to implement WSPs in the field. It is also expected that they will also be able to realize the real benefits and the challenges of safe water supply and to identify the areas where emphasis should be given. The most fruitful means of consistently ensuring safe drinking-water supply is through the use of a comprehensive risk assessment and risk management approach that encompasses all steps from catchments to consumers' water supply scene. The safe water supply approach has been developed to organize and systematize a long history of management practices applied to drinking water and to ensure the applicability of the practices to the management of drinking water quality ('Managing drinking-water quality from catchments to consumer', WHO,2005). According to World Health Organization (WHO) the primary objectives of a WSP in ensuring good drinking water supply practice are: (i) the minimization of contamination of source water, (ii) the removal of contamination through treatment processes, and (iii) the prevention of contamination drinking storage, distribution and handling of drinking water ('Managing drinking-water quality from catchments to consumer', WHO, 2005). It is high time that the options available for water supply in the arsenic affected areas can be brought into two major categories: alternative arsenic-safe water source and treatment of arsenic contaminated water. It should be kept in mind that dug wells, pond sand filter and pipeline water supply system can be potential sources of water supply to avoid arsenic ingestion through implementing social acceptability technique. Various organizations such BAMWSP, JICA/AAN, Danida, UNICEF and some other organizations have come forward with the aid in alternative arsenic-safe water source by installing Dug well Sand Filter (DSF), Pond Sand Filter (PSF), Pipeline Water supply System (PWSS) collectively and comprehensively to fulfill the requirements of the rural people. Furthermore, the right to water (UN, 2003), places a clear responsibility on Governments to ensure access to safe and adequate water supplies. Although better health protection is reason in its own right for the adoption of strategies to improve drinking-water quality, international policy is also a key factor. Water suppliers have a duty of care to persons utilizing the water or service that they supply and therefore, need to be aware of the regulatory and policy framework within which they must operate including common law (where appropriate), statute, policy, guidelines and best management practice. In this situation an iterative cycle that encompasses assessment of public health concerns, risk assessment, the establishment of health-based targets and risk management is obligatory. Feeding into this cycle is the determination of environmental exposure and the estimation of what constitutes a tolerable (or acceptable) risk (Ahmed and Rahman 2000). Supply of safe drinking water has been one of the main agenda of civilizations and continuing through the MDGs. But most of the populations in the developing countries and other stressed areas, irrespective of the access of improved and not-improved technological options, have been exposed to the risks of drinking biologically and/or chemically contaminated water at the consumption point. The objectives clearly calls upon a few systems linked 143 into one WSP system including various types and levels of timely actions by multiple actors within the sub-systems as well as the WSP system. The Arsenic Policy Support Unit (APSU, 2005) of the Ministry of Local Government Rend Development & Cooperatives with substantial support from DFID and other external/international partners; facilitated the introduction and initial development of WSP. For getting pure drinking water, the degree of arsenic contamination may create pressure for rural household to shift from individual to community-based system in specific geographic units (Arsenic Mitigation Initiative, 2000). The arsenic catastrophe in Bangladesh now appeared as a 'real disaster that is now affecting myriad people by physically, physiologically, mentally and economically (WHO and UNICEF, 2000).

2. METHODOLOGY:

2.1 Selection of study area:

The Chowgacha village which is under Jessore district in Bangladesh was used as model for investigating water quality status and sanitary inspection for ensuring the technical capability and social acceptability for the region. Four areas are selected on the basis of the geological conditions and different communities. Phulsara- Arardha, Dashpakhia and Kustia-Ajmatpur village were chosen as model for determining the Water quality status. The following figure shows the study area.

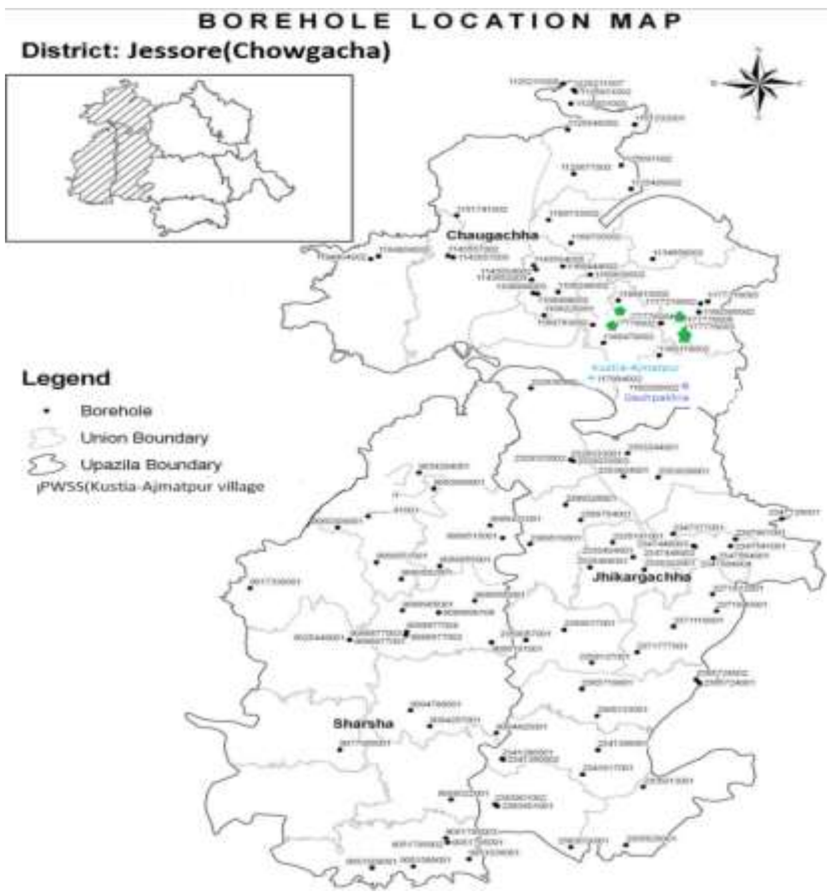

Figure 1: Study area of existing water supply system

2.2 Collection of water samples:

Sample collection: Water samples from two Pond Sand Filters (PSF) of Phulsara and Dashpakhia, two Dug well Sand Filter (DSFs) from Arardha and Shibnagar and one Pipeline Water Supply System (PWSS) of the Kustia-Ajmatpur village it's both raw water to the final filtrate water were collected and analyzed to observe variation in water quality parameters. Samples for bacteriological analysis were collected and transported in ice-box.

2.3 Selection of water quality parameters:

The three important water quality parameters arsenic, iron and bacteriological quality were selected from health risk point of view. Fecal coliforms (FC) and Total coliform were analyzed to represent bacteriological quality of water, as they are the most commonly used indicator bacteria. Other physical and chemical water quality parameters (Turbidity, color, pH, iron, nitrate, and sulfate) were also analyzed

Firstly, Fecal coliforms and Total coliform (FC) were analyzed by membrane filtration method. Secondly, samples for analysis of turbidity, color, nitrate, and sulfate were collected in 500 ml plastic bottles. In addition, Turbidity of water samples was measured by turbid meter. Furthermore, Nitrate, manganese, sulfate were determined by Hatch DR/2010 UV-Visible Spectrophotometer. Besides, Samples for analysis of arsenic, iron, were collected in the acidified 250ml plastic bottles whereas Iron and ammonium of samples were determined by Nessler methods. Free chlorine was measured by DPD method. PH of water samples were measured with pH meter at the laboratory instantly.

2.4 Sanitary Inspection

Sanitary inspection requires in the water supply area to assess the sanitary integrity and potential hazards in the environment that may affect water quality, particularly microbiological quality. Sanitary condition is directly linked with microbial quality which indicates the potential sources of contamination of the water supply system. It causes risk to the entire inhabitants of the surrounding sites. Focus Group discussion can play effective role for providing information about the full status of this area. So, to understand the contamination of the region, it is urgent to assess the potential causes of contamination when it occurs and to promote control measures to microbial water quality. In this case, sanitary inspection plays a crucial role for water supply system.

3. RESULTS AND DISCUSSIONS:

To get a clear scenario of the water supply system in Chowgacha Upazilla under Jessore district and to know the related socio-economic problems, a questionnaire survey was conducted among the local dwellers. The study investigated the present situation of safe water supply, the difficulties, barriers and obstacles to implement safe water supply. Behavior of an individual is largely determined by his characteristics. These characteristics were age, gender, family size, and area type.

Gender

Gender identification is the most important part of the survey. Among all the respondents, 70% people were male while 30% people were female. Women are directly engaged in water related household works in Bangladesh that's why to complete the study effectively about 50% women were interviewed among all the respondents.

Family size:

The family size of the respondents ranged from 4-9 with an average of 5.84. From my study it shows that (1-2), (2-3), (3-4), (4-5), (5-6), (6-7), (7-8), (8-9), (9-10), the family members were increasing. Majority (40%) of the respondents was in the medium group (4-5 family members) followed by small group (upto 4 family members) 31% and large (>6 family members) 29%.

Water related issues

Water related different factors such as sources of water to use, their taste, availability, arsenic condition, and the user's satisfaction level are important to categories for the interpretation of the different components of the water safety plans and its present situation.

Source of water to use

Pond sand filter, Dug well sand filter, dug well, pipe water were the different sources of water/ all cases of drinking, cooking and bathing. In case of drinking, it was found in the study area that Dug well and Pond sand filter water are used by 58% and 31% respondents whereas minority of the respondents use other sources (Figure 2). On the other hand, 2% respondents used shallow tube well water and 9% respondents used pond water for their cooking. Beside these, 53% of the respondents used the Dug well for their cooking purpose followed by 33% Pond sand filter water, 8% Pipe water and 2% shallow tube well water respectively (Figure 4).

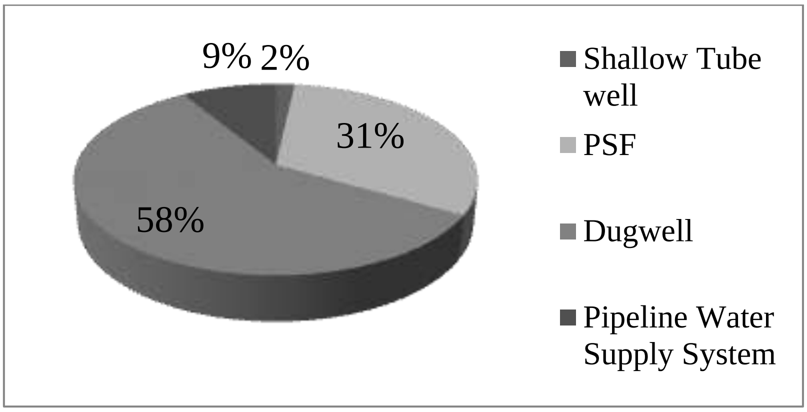

Figure 2: Sources of water according to use for drinking purposes.

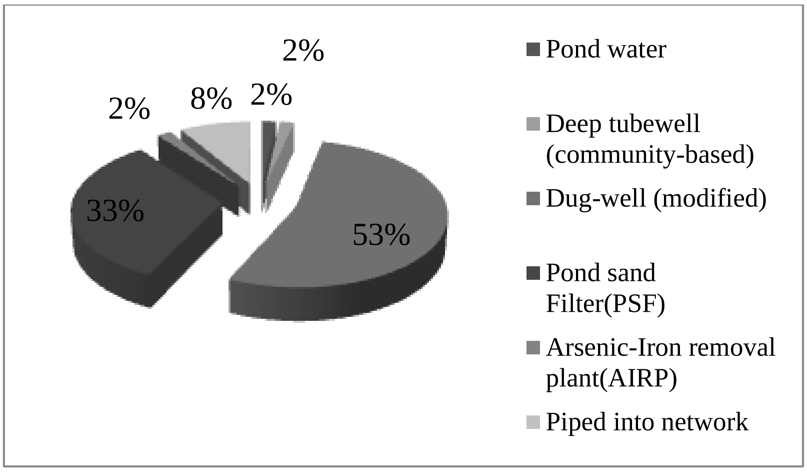

Figure 3: Sources of water according to use for cooking

3.1 Water Quality of Alternative water supply options:

3.1.1 Microbiological quality:

The reliability of total Coliform (TC) and fecal Coliform (FC) bacteria shows an indicator of the presence of pathogens in water.

Fecal Coliform:

Fecal Coliform provides stronger evidence of the possible presence of fecal pathogens. From my study (Figure 14) reveals that Feacal Coliform was found in the PWSS of the Boar water 20/100 ml CFU and its supply water found 80/100 ml CFU whereas the Feacal Coliform of dug well in the Arardha village found its raw water is 192/100 ml CFU. On the other hand, the dug well in the Shibnagar village found 150/100 ml CFU and its treated water found 100/100 ml CFU. Besides, in case of PSF's raw water in the Phulsara village found 150/100 ml CFU and its treated water found 20/100 ml CFU.

Total Coliform:

The total Coliform of the PWSS of the raw (Boar) water was 130/100 ml CFU and its filtrated water found 220/100 ml CFU while the total Coliform of the dug well in the Arardha village was 2100/100 ml CFU and its treated water found 0/100 ml CFU (Figure 15). On the contrary, the dug-well in the Shibnagar village found 40/100 ml CFU of its raw water and its supply water found 140/100 ml CFU that indicate remarkable changes in this region. Besides, in Phulsara village raw water from the PSF found 88/100 ml CFU and its treated water found 1500/100 ml CFU which was higher than that of the dug well whereas the total Coliform of the PSF in the Dashpakhia village was 640/100 ml CFU of raw water and 48/100 ml CFU of the treated water.

3.1.2 Chemical Quality

Arsenic Concentration (As):

In Bangladesh both of government and NGOs organizations were so much aware about the arsenic but in my study showed that water from PSF in the Phulsara village was found to be contaminated with arsenic while the maximum number of PSF was found in Dashpakhia village of Chowgacha Upazilla, among which majority of them were contaminated with arsenic (Figure 8). Only about 5 DSFs between the Arardha and Shibnagar village were contaminated and all of them were free from arsenic.

Iron concentration (mg/l):

From my study report (Figure 9) shows the union-wise distribution of iron concentration range in different alternative safe water options. The Bangladesh permissible limit for iron in drinking water is 1 mg/L. Out of 69 active Dug wells 26% exceeded the Bangladesh standard. The lowest level of contamination was found in Arardha village of Chowgacha Upazilla. Besides, the PSFs of the Phulsara and Dashpakhia village exceeded the Bangladesh standard.

Phosphate concentration (PO_4^{3-}):

From (Figure 10) represents the lowest amount of phosphate ion found in the PWSS of Kustia-Ajmatpur village and dug well of the Arardha and Shibnagar village. On the other hand, the highest amount of phosphate concentration was found in the PSF of the Phulsara village both its raw and supply water about 2.87 mg/l and 4.70 mg/l whereas the Dashpakhia village of Chowgacha Upazilla also shows the highest amount of phosphate ion concentration both its raw and supply water about 0.92 mg/l and 1.48 mg/l respectively.

Nitrate concentration:

From my study, it gave information (Figure 11) that concentration of nitrate in case of raw water (Boar) of the PWSS was more than its treated water. But in case of the dug well in the Arardha and Shibnagar village were about 5.9 mg/l in raw water, 4.2 mg/l in treated water, 4.2 mg/l in raw water and 2.9 mg/l in filtrated water respectively which shows concentration range below the Bangladesh standard. On the contrary, the concentration of the PSF of the Phulsara village was 5.6mg/l and 3.2mg/l. whereas the concentration of the PSF in the Dashpakhia village was under detection range.

Free Chlorine concentration:

Among numerous types of PSF only few of the Pond Sand Filter (PSF) in the Dashpakhia village utilizes chlorine after treatment while the PSF of the Phulsara village is very critical situation from my study report (Figure 13). On the other hand, the dug-well of the Arardha and Shibnagar village used bit amount of chlorine than the PSF of the Dashpakhia village. The quality of the boar water is very good and its treatment process is excellent so they utilized less amount of chlorine after treatment of water.

Ammonia Concentration:

Majority of the active Dug wells and Pond Sand Filters (Figure 12) had ammonia levels above the Bangladesh Standard about 0.68 ppm, while about 19% and 12% exceeded the WHO Guideline Value about 1.5 ppm. The number of PSFs was found in Phulsara and Dashpakhia village of Chowgacha Upazilla was free from ammonia

Status of pH:

This graph (Figure 4) shows that the average pH level of pipeline water system is 8.33 and 8.79 both its raw and treated water. The water can be considered as slightly alkaline. Besides, the pH level of pond water of this region is comparatively low. It is almost below 8.1. The medium pH level is found in the water from Dug well in the Arardha and Shibnagar village about 8.29, 8.29 and 8.70, 8.20 of its raw and treated water respectively.

Electrical Conductivity:

The level of Electrical Conductivity (EC) (Figure 5) in the dug well of the Arardha village of the raw water 1429 µS/cm and its treated water found 1364 mg/l while in Shibnagar village found 485 µS/cm and its treated water found 525 µS/cm. Beside this the raw water of the PSF in the Phulsara village found 541 µS/cm and treated water found 525 µS/cm while the EC value of the raw water of the Dashpakhia village measured 701 µS/cm and 709 µS/cm of the treated water. The EC value of the PWSS of the raw (boar) and treated water found 166 µS/cm and 176 µS/cm.

TDS (Total Dissolved Solid):

From my analysis report (Figure 6) it has been found that the TDS level of almost all water supply samples were below the standard level. But a remarkable change is found in TDS of 716 mg/l in raw water of the Dug well in the Arardha village and 682 mg/l of the treated water whereas the TDS concentration of the raw water found 244 mg/l of the PSF of the Phulsara village and 265 mg/l of the treated water. Besides, the TDS concentration of PWSS was lowered with compared to the pond water of the PSF.

Turbidity:

The Bangladesh standard limit for turbidity in drinking water is 10 NTU. From my study (Figure 7), reveals that the high turbid water was found in PSF of the raw water in Phulsara village about 146 NTU and 14 NTU its treated water. On the other hand, a remarkable change has noticed about 317 NTU in Dashpakhia villages from its raw water of PSF and 41 NTU of the treated water which exceeds Bangladesh standard range. While the turbidity of the raw water of the dug-well of the Shibnagar village found 2 NTU and 5 NTU of its treated water which is below the range of Bangladesh standard. But the turbidity of the PWSS was lowered below the Bangladesh standard of 10 NTU.

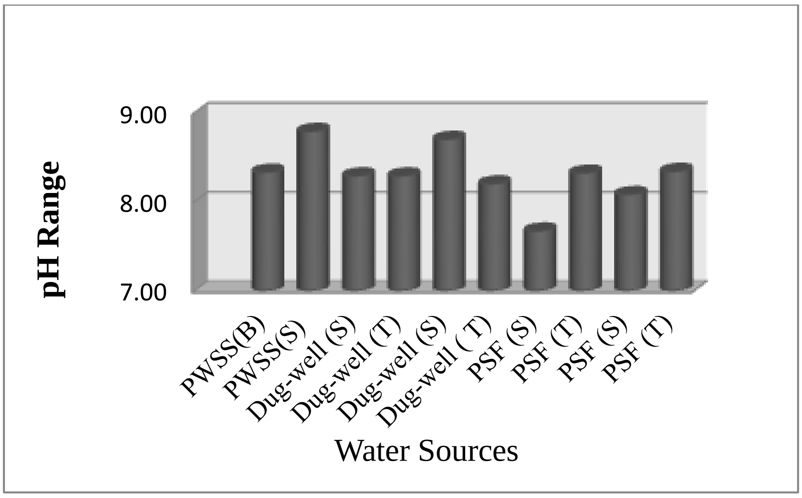

Figure 4: Comparing pH level among the PSF, Dug well and pipeline water supply system both its raw and treated water

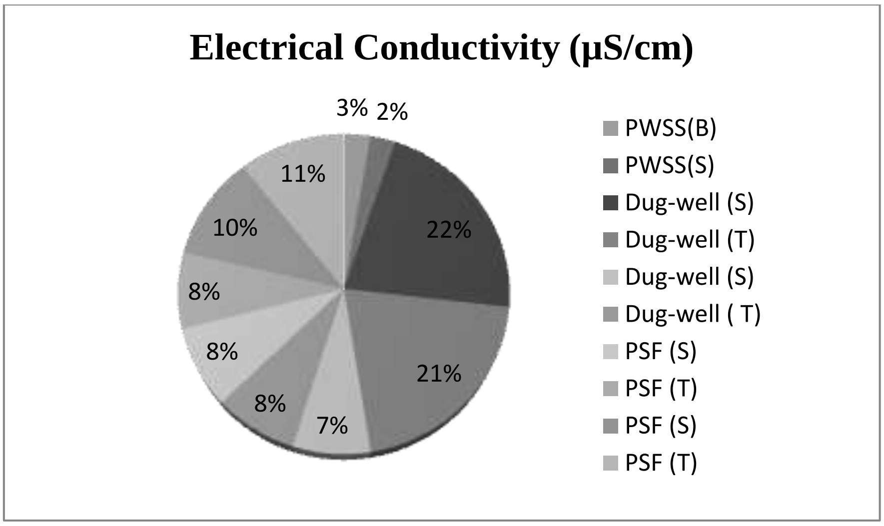

Figure 5: Electrical Conductivity of the raw and treated water among the PSF, Dug well and PWSS of the water supply system.

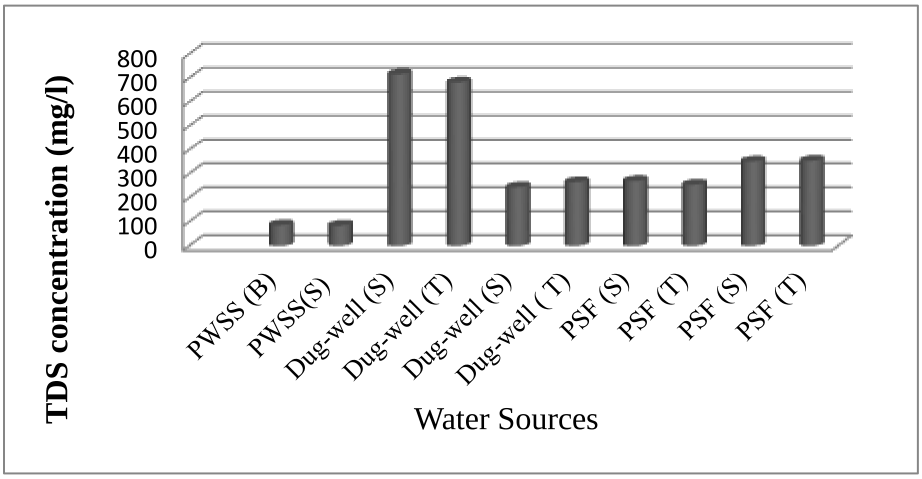

Figure 6: Comparison of Total Dissolved Solid (TDS)of the raw and treated water among the PSF, Dug well and PWSS.

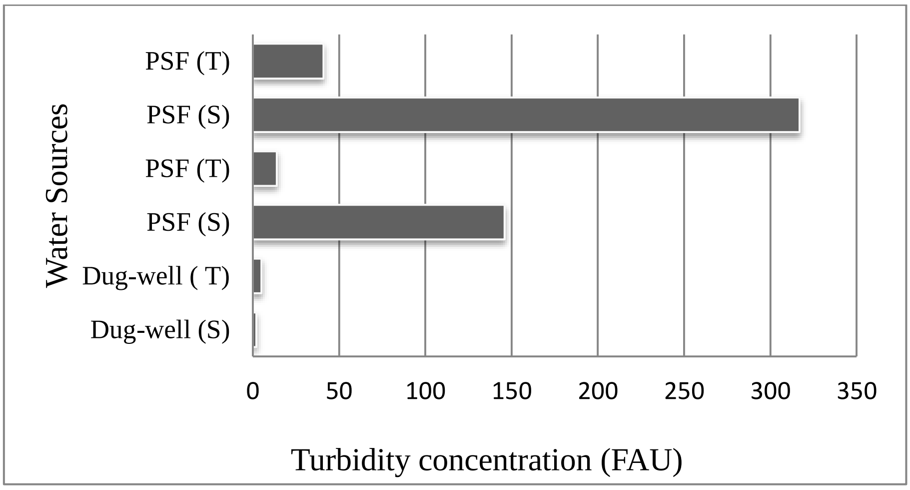

Figure 7: Turbidity of the raw and treated water of The PSF, Dug well and PWSS system.

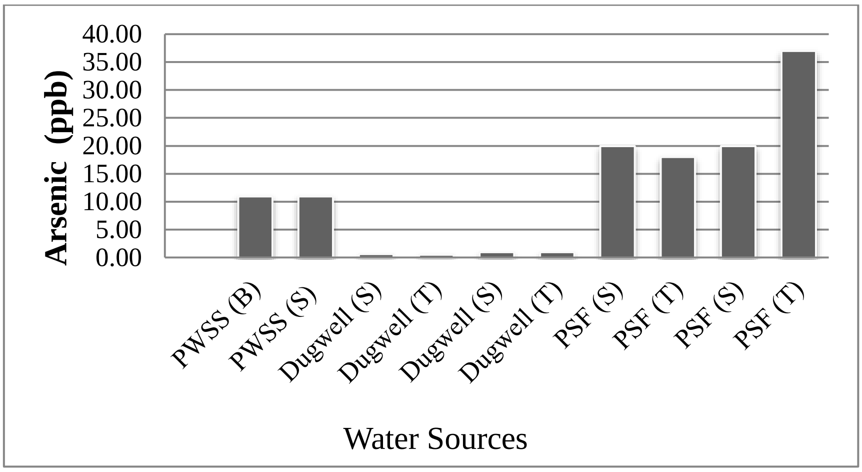

Figure 8: Comparison of Arsenic concentration of the raw and treated water of the PSF, Dug well and PWSS system.

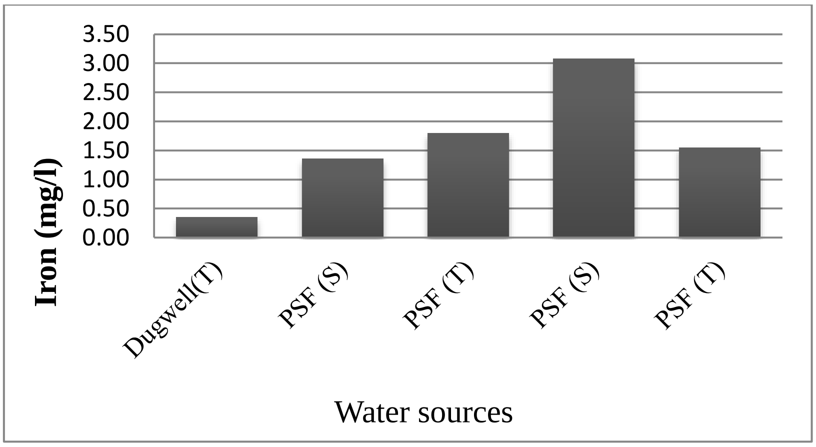

Figure 9: Comparison of Iron concentration of the raw and treated water of the PSF, Dug well and PWSS system.

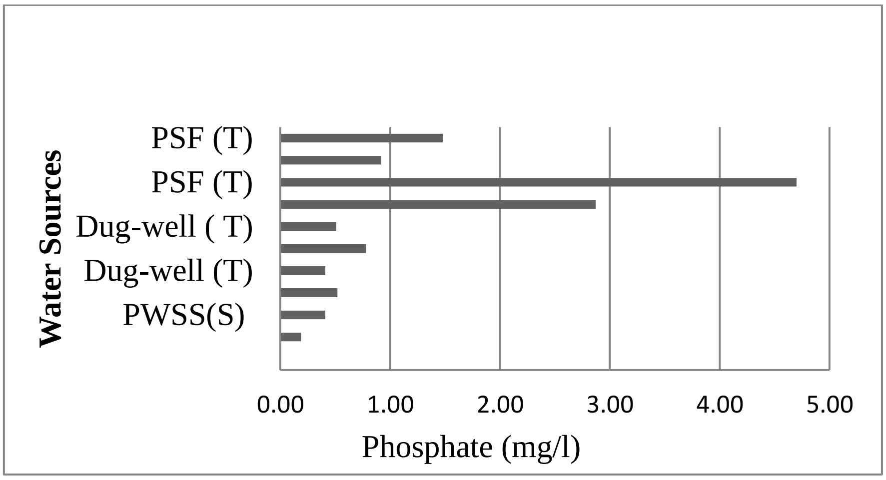

Figure 10: Phosphate concentration of the raw and treated water of the PSF, Dug well and PWSS system.

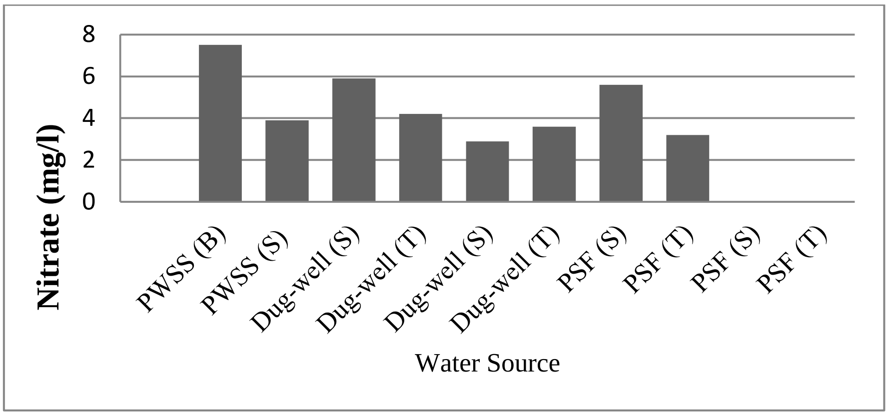

Figure 11: Nitrate concentration of the raw and treated water of the PSF, Dug well and PWSS system.

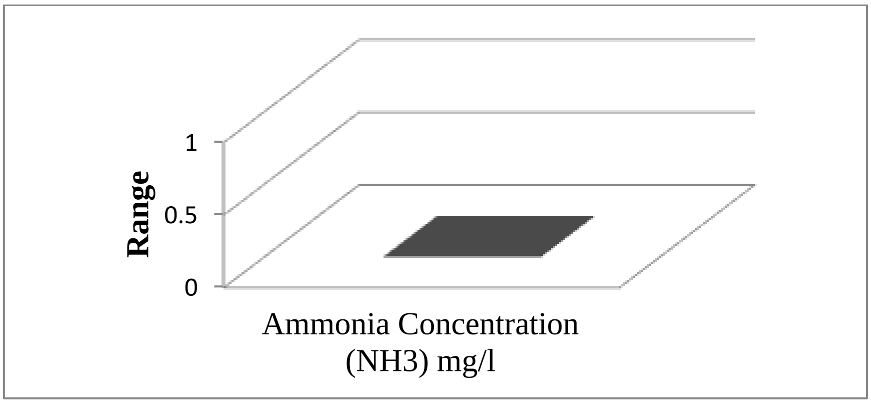

Figure 12: Ammonia concentration of the raw and treated water of the PSF, Dug-well PWSS.

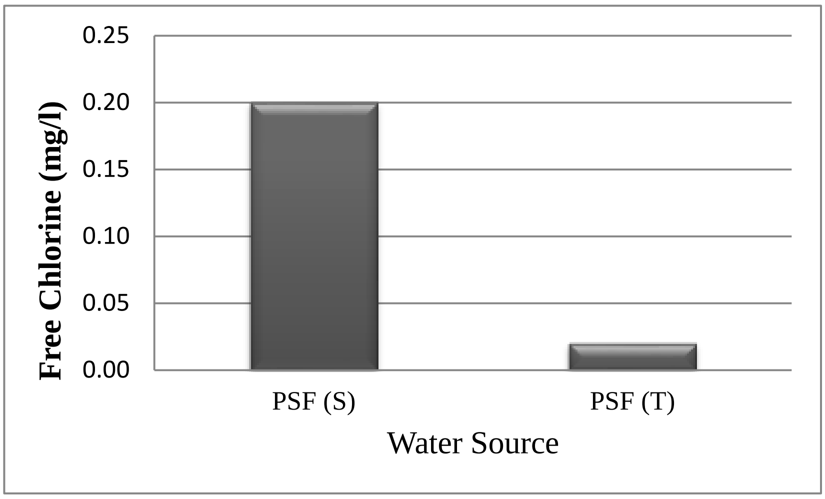

Figure 13: Comparing Chlorine (Cl2) of the raw and treated water of the PSF, Dug well and PWSS system.

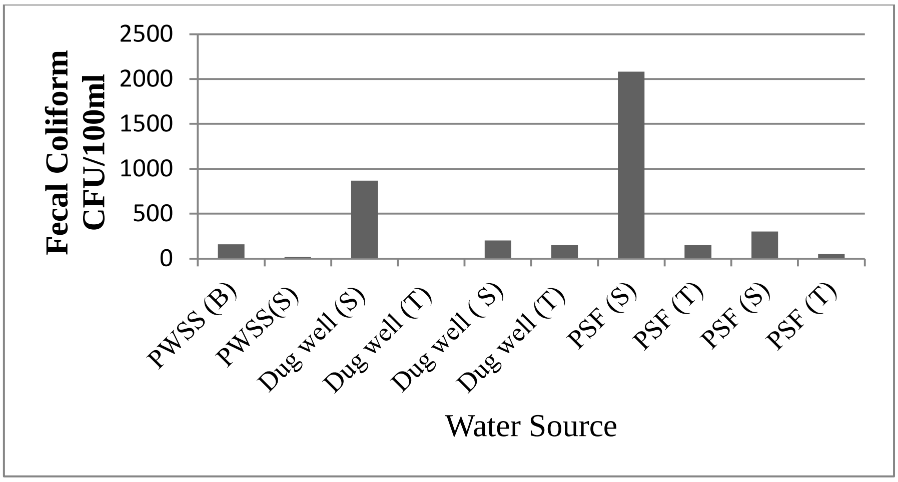

Figure 14: Fecal Coliform count of the raw and treated water of the PSF, Dug well and PWSS system.

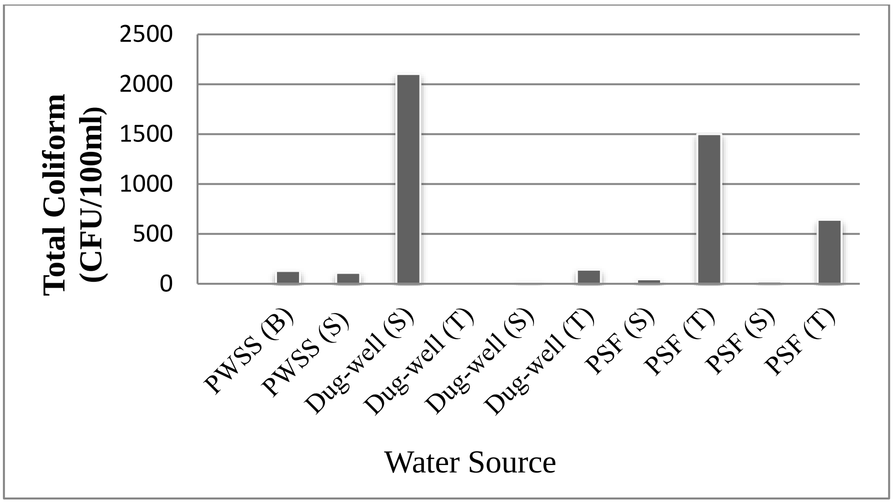

Figure 15: Total Coliform count of the raw and treated water of the PSF, Dug well and PWSS system.

3.2 Description of the Water Supply options:

3.2.1: Pond Sand Filter:

In arsenic prone areas and in coastal belt, an alternative and reliable option for drinking water supply is PSF. To purify surface water usually pond water for domestic water supply a package type slow sand filter unit developed which is called PSF **(**Water Aid Bangladesh, 2006). To make water Potable or drinkable, PSF is regarded as the simplest technology to treat surface water for the well-being of the people (position report). Near or the bank of the pond, slow sand filter is set up which does not dry up during the dry season. A manually operated hand tube well is utilized for the collection of water from the pond to feed the filter bed. A prospective option for the development of surface water based water supply system is the construction of community type Slow Sand Filters (SSFs) commonly known as Pond Sand Filters (PSFs).

3.2.2: Dug wells Sand Filter:

Even during the Mohenjo-Daro and Harappa civilization more than 4000 years ago the use of Dug wells in Asia was known. Dug well which was known as "Jam Jam”. Prophet Hazrat Mohammad used to drink water. Due to induction of tube wells, which proved more convenient as far as bacterial contamination is concerned, the culture of dug well however died down. Due to the bacterial contamination of the dug well water and consequent enteric diseases prevailing among the users so that the advent of hand tube wells the use of dug wells subsided largely.

3.2.3: Pipeline Water Supply System:

Piped Water Supply System (PWSS) is a device that purifies Boar water and supplies them safe water to a large number of household (400) through a pipe line network (JICA/AAN Arsenic Mitigation Project, 2004). It is considered as one of the ultimate goal of the water supply options to provide water to the close proximity of the consumers by protecting water from external contamination. The Pipeline Water Supply System (PWSS) is a surface water treatment system combined with multistage filters and delivery system. This treatment plants consist of separate two units and each unit consists of five up-flow roughing filter (URF) using different size of gravels and slow sand filter (SSF). Raw water is influenced to filter continuously with slow velocity and filtration is operated all day long. In the treatment plant, the water passes through five gravel chambers. Almost all particles are gradually removed there. The SSF removes fine particle and pathogenic bacteria. The water is purified through this process, and finally bleaching powder/free chlorine for disinfection is taken at a reserve tank. Then treated water is supplied to village through pipeline (AAN).

3.3: Performance of Community-based water supply systems:

It can be assumed that community preference for PWSS was highest among all other available technologies in spite of the few PSFs. This small number may indicate the unavailability of ideal ponds required for such construction. On the other hand, it is also true that villagers are not habituated to use PSFs in these areas like people of the coastal belt areas where surface and rainwater harvesters are the only sources for drinking water. It can also be noticed from that the rating of PSF and DSF were fairly close. The largest number of surface water are available everyplace that is why it is possible to get pond water and pipe water easily and conveniently. PWSS is the best way that take considerations about the distance that they can fetch water easily and in that case PWSS supply water through the tap water system. On the contrary, PSFs do not supply water efficiently because people have to come to fetch water after meeting other requirement. PSF can be effective water supply system if we take into considerations about avoiding our pond from natural and anthropogenic interferences.

3.4: Sanitary Integrity:

Sanitary integrity is most crucial part of the water supply areas where microbial contamination of the region is so high that cannot meet the pure water demand of the people. To know the overall processes of the potential hazards in the environment which causes water quality deterioration sanitary inspection can be useful tool to assess the microbial quality of the water by using observation techniques. It is an effective tool for assessment of the prevailing sanitary situation of the raw and filtered water of the water supply options and estimation of the risk based on the screening scores on a scale of 0 (no risk) to 10 (very high).

T**able 1 :** Social Risk Scores among alternative safe water devices (for raw water).

Options (water Supply System)	Type (Raw water)	Risk Score (%)	Risk Category
Pond Sand Filter (PSF)	Pond water	8/10	High Risk
Pipeline Water Supply System (PWSS)	Boar water	4/12	Medium
Dug Well Sand Filter (DWSS)	Dug Well water	5/11	Medium

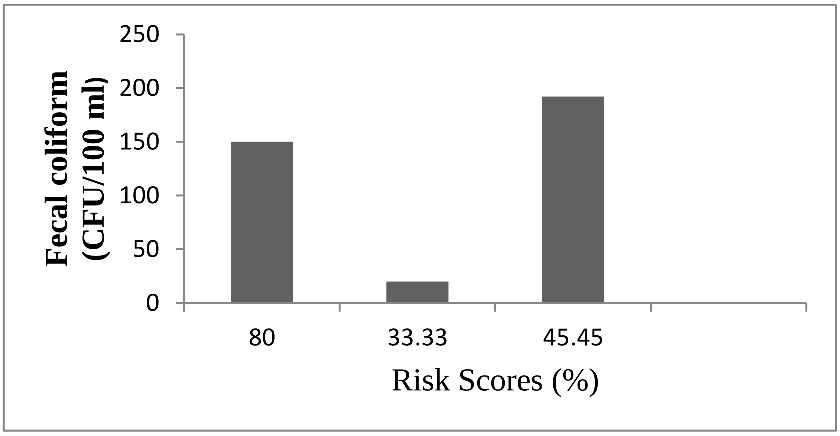

Figure 16: Relationship between Fecal Coliform and social risk of raw water system.

Sanitary integrity provides us the way about the potential consequences of the risk due to the contamination of microbial pathogens mainly coliform bacteria by making the correlation between the Feacal and total coliform with respect to risk scores. From the risk scoring table 3, it is very clear to observe that risk level is so acute of the PSF of the Phulsara village whereas it is low of the PSF of the Dashpakhia village. On the other hand, the situation of the PWSS has no risk compare to the DSFs of the Arardha and Shibnagar village which has low risk due to the proper maintenance and monitoring programme.

Table 2: Social Risk Scores for alternative safe water devices (for Supply water).

Options (water Supply System)	Type (Supply water)	Risk Score (%)	Risk Category
Pond Sand Filter (PSF)	Pond water	6/10	High Risk
Pipeline Water Supply System (PWSS)	Boar water	3/12	Low
Dug Well Sand Filter (DWSS)	Dug Well water	4/11	Medium

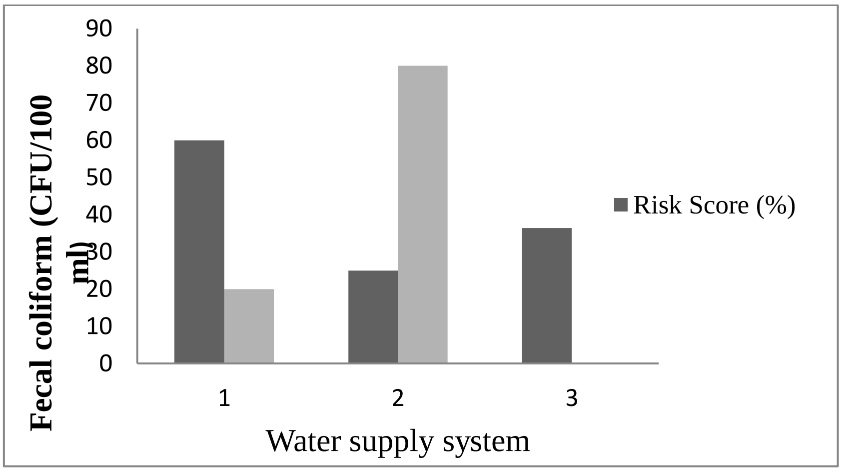

Figure 17: Relationship between Fecal Coliform and social risk of water supply system.

The high risk scores indicate that high microbial counts. This problem can be eradicated through the implementation of the appropriate training to the community, raising awareness to the affected community, behavioral change and ensuring effective participation to the community. To solve this problem, it is very effective for the proper maintenance of the water supply system. It is very difficult for the PSFs and DSFs system to perform actively due to lack of the proper operation and maintenance it will lead to the contamination of the overall system. On the other hand the sanitary situation of the PWSS is so good that there is lack of the risk of the microbial pathogens and ultimately lead to contamination free safe water.

3.5: Functionality of alternative options:

Among the three options namely two PSFs, two DSFs and one PWSS system which do not functions appropriately. In Phulsara village, PSFs do not act properly due to the lack of essential equipment while in the Dashpakhia PSF, its functionality is quite good compare to the Phulsara. Besides, the DSFs of the Arardha village do not function properly with compare to the dug well of the Shibnagar village which works so nicely. Moreover, the PWSS of the Kustia-Ajmatpur village has been work so adequately and properly because of having essential commodities.

3.6: Operation and Maintenance of alternative options:

Most of the alternative water supply options of the Chowgacha village do not work properly due to shortage of proper operation and maintenance cost. In case of PSFs of the Phulsara village, inhabitants of the region do not put more emphasis for the operation and maintenance of the pond water. They use the water for doing their all works without considering its importance. Besides, they are not cautions of getting pure water due to the lack of willingness. They do not want to invest money for buying chlorine dose for applying it after water treatment to get contamination free water. Whereas in the PSFs of the Dashpakhia village has taken immediate step to gets pure water by set-up fencing around the pond. Moreover, in the Arardha and Shibnagar village the DSFs, the people of those villagers are so collaborate to invest money for the proper operation and maintenance. They use chorine sequentially for the treatment of the water. Furthermore, in case of PWSS of the Kustia-Ajmatpur village, through the active participation of the community members and comprehensive knowledge of the various organizations like the JICA and LGD they maintain the overall process and operation effectively.

3.7: Options limitation:

There are several criteria: Initial and running costs, ease of implementation, operation and maintenance, continuity and flow of supply, sustainability of preventing bacteriological contamination and acceptability of the community for the assessment of the options they prefer. Each of the options has its own strengths and weakness.

3.8: Future strategies:

Due to the limitation of the various steps, it is necessary for better understanding of the problem that is why we can plan easily for further research programme to get rid of this limitation to carry out the process for getting better solution. The data concerning for each type of option is fairly limited. In that case, awareness-building activities can be an effective solution to raise the awareness level of the community about the arsenic related problem to find mitigation options. The aim of the project was to generate new knowledge on the provision of safe drinking water, technical viability and community acceptance. Various sources of safe drinking water may be considered in future research.

4. CONCLUSION:

The water sector in Bangladesh has made significant efforts to develop and implement safe water supply for rural inhabitants. The World Health Organization promotes the use of water safety plans in the 3rd edition of the Guidelines for Drinking Water Quality as a key component of an overall water safety framework. The results of the study had been very positive and the success of a diverse range of organizations in implementing safe water supply requires an integrated approach to understand and solve key problems in these areas. All alternative water supply systems (PSF, DSFs and PWSS) are great importance in those areas where water supply system is scarce. Such an approach may involve expertise from chemical, physical, biological, microbiological, social and economic components so that at least the quality aspects of water stress may be addressed satisfactorily and as a result making quality water available to all the stakeholders in the region. The existing NGOs can play important roles in the proper implementation of safe water supply. In case of drinking, it was found from the study area that Dug well Sand Filter and Pond Sand Filter water are used by 58% and 31% respondents whereas minority of the respondents use other sources. On the other hand, 2% respondents used shallow tube well water and 9% respondents used pond water for their cooking. Beside these, 53% of the respondents used the Dug well sand Filter for their cooking purpose followed by 33% Pond Sand Filter water, 8% Pipe water and 2% shallow tube well water respectively. Perception about the drinking water which is safe for the respondents was found mostly 67% among all the respondents followed by moderately safe 33%. In this study 9% of the respondents indicated that they did not know about the water safety plans. In the study area, it was mostly found that whole the year children, women were in diarrheal and skin diseases although they responded most of the drinking water sources are safe. Compared with the sanitary inspection these results indicated the total ignorance and lack of knowledge about the safe drinking water and the spread of water related diseases. Sanitary integrity provides us the way about the potential consequences of the risk due to the contamination of microbial pathogens mainly coliform bacteria by making the correlation between the Feacal and total coliform with respect to risk scores. From the risk scoring table, it is very clear to observe that risk level is so acute of the Pond Sand Filter in the Phulsara village whereas it is low of the Pond Sand Filter of the Dashpakhia village. On the other hand, the situation of the Pipeline Water Supply System has no risk compare to the Dug well Sand Filters between the Arardha and Shibnagar village which has low risk due to the proper maintenance and monitoring programme. From my study, it can be assumed that community preference for PWSS was highest among all other available technologies in spite of having few PSF and DSFs. On the other hand, it is also true that villagers were not habituated to use PSFs in these areas like people of the coastal belt areas where surface and rainwater harvesters are the only sources for drinking water. It can also be noticed from (Table 4) that the rating of PSF and DSF were fairly close. The above table shows that large number of surface water are available everyplace that is why it is possible to get pond water and pipe water easily and conveniently. PWSS is the best way that take considerations about the distance that they can fetch water easily and in that case PWSS supply water through the tap water system. PSF can be properly treated with the addition of chlorine to make ease and perfect for everybody considering. The quality of the PWSS is very good but it is not so effective because of the initial and maintenance cost. PSF can be effective water supply system if we take into considerations by protecting our pond from natural and anthropogenic interferences. Finally, it can be concluded that safe water supply system are dynamic by their nature and require regular review and updating. Different water supply projects need to ensure that there is regular interaction and collaboration to support widespread implementation of water safety plans and the development of a water safety framework for Bangladesh.

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