SUITABILITY OF POND SAND FILTERS AS SAFE DRINKING WATER SOLUTION IN STORM SURGE PRONE AREAS OF BANGLADESH: A CASE STUDY OF POST-AILA SITUATION IN SHYAMNAGAR, SATKHIRA DISTRICT, KHULNA

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ABSTRACT

This study focuses on the suitability of Pond Sand Filter (PSF) as safe drinking water option in storm surge prone areas in the south-western coastal areas of Bangladesh both at normal times as well as during disasters. This study area is subjected to floods, tidal surge and river erosion but most commonly to cyclones and storm surges. Now with added effect of climate change, such calamities occur more frequently. River water in the area is saline and thus availability of potable water for drinking purpose is already a big challenge. Recently Pond Sand Filter (PSF) was introduced as a suitable option for water supply that treats rain water reserved in a pond. PSF is a simple technology in which water is pumped from a pond and passed through a number of chambers containing sand and gravel. The treated water is usually safe for drinking.

Cyclone Aila, a category 1 cyclone, hit the Satkhira and Khulna districts of Bangladesh in 2009 and resulted in devastations which are still evident. The cyclone induced storm surge brought much saline water inland as many ponds and tube-wells became unusable. Of the seven upazilas in Satkhira district, Shymnagar upazila was most severely affected (where 243,293 were affected out of a total affected mass of 569810). Munshiganj union of Shayamnagar upazila was selected as the study area where more than 25,000 people were affected by the disaster. In this study area, intervention of PSFs had started in 1984 as one of the drinking water options and pond sand filters seemed a well accepted technology. However, its suitability in the current disaster and salinity context has not been assessed and therefore, functioning of randomly selected PSFs were studied. The thesis discusses the causes and effects of water crisis in such storm surge prone areas and various water interventions over time.

As research methods, both secondary and primary sources were applied. The tools utilized were informal interview, Key informant interview and physical observation. The groups targeted to be interviewed were community people/ users of the PSF, care-takers maintaining PSF, local elites (such as members or chairman of the village) and officials of non-governmental and governmental organizations. The PSFs were assessed based on the drinking water quality, management of the technology and its resilience towards disaster.

In the study, it was found that during normal time, the functioning of PSFs and the quality of drinking water depended upon availability of fresh water in the ponds and its maintenance. According to the locals and experts, PSF's resilience towards disaster could be enhanced through raising pond banks to prevent intrusion of saline water during disasters. In these regards, communities' collective effort and contribution was predominant which seemed to be missing. The operation of PSFs after disasters depended upon quick repairing and recovery of PSFs and its adjacent ponds. As a result of time constraints, no conclusion on the suitability of PSFs can be drawn. However, for further study, larger sample size of PSFs and target locations under various geographical contexts can be taken. Modified versions of PSFs could also be assessed in comparison to the regular ones to understand its suitability in the region.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

BDPC	Bangladesh Disaster Preparedness Center
BWDB	Bangladesh Water Development Board
CDMP	Comprehensive Disaster Management Program
CNT	Carbon Nanotubes
DHTW	Deep Hand Tube Well
DPHE	Department of Public Health and Environment
GO	Governmental Organization
IPCC	Intergovernmental Panel on Climate Change
KII	Key Informant Interview
NGO	Non-Governmental Organization
NTU	Nephelometric Turbidity Units
Oxfam GB	Oxfam Great Britain
PSF	Pond Sand Filter
RO	Reverse Osmosis
RWH	Rain Water Harvesting
UNDP	United Nations Development Program
UNICEF	United Nations International Children's Emergency Fund

CHAPTER 1: INTRODUCTION

1.1 Background of the Study

The south-west coastal regions of Bangladesh have been experiencing acute shortage of safe drinking water and increase in salinity intrusion in surface and ground water over the past few years. The reason is manifold and complex. Due to geographical disadvantage, this south-western region is commonly subjected to floods, river erosion and tidal surge but most importantly cyclones and storm surges. It has been estimated that Bangladesh is on the receiving end of about two-fifths of the world's total impact from storm surges (Dasgupta, et al., 2011). The phenomenon of re-curvature of tropical cyclones in the Bay of Bengal is the single most cause of the disproportional large impact of storm surges on the Bangladesh coast. In addition, the funnel shaped coast line of Bangladesh is characterized by a wide continental shelf, especially off the eastern part of the country. This wide shelf amplifies the storm surges as the tangential sea-level wind-stress field associated with the tropical cyclone pushes the sea water from the deep water side onto the shelf. Being pushed from the south by wind stress, the water has no place to go but upwards and results into storm surge. Also, the coastal areas and off-shore islands of Bangladesh are low lying and very flat. The height above mean sea level of the coastal zone is less than 3m (Sarwar. M, 2005). Records indicate that the greatest damage during cyclones has resulted from the inundation caused by cyclone-induced storm surges. According to Environment Department of the World Bank, existing literature indicates a 1.5–9 m height range during various severe cyclones. Storm-surge heights of 10 m or more have not been uncommon (Dasgupta, et al., 2011).

In addition, the added effects of climate change have caused hazards in this region to occur more frequently than before and with greater magnitude. The scientific evidence indicates that increased sea surface temperature with climate change will intensify cyclone activity and heighten storm surges. Surges will be further elevated by rising sea level as thermal expansion and ice caps continue to melt. Hence, the effects of climate change, increase in sea surface temperature and sea-level rise, are likely to exacerbate Bangladesh's vulnerability to cyclones. Larger storm surges threaten greater future destruction, because they will increase the depth of inundation and will move further inland - threatening larger areas than in the past (Sarwar. M, 2005).

Hence lives and property in lower-lying coastal districts along the Bay of Bengal are highly vulnerable to inundation from cyclone-induced storm surges. Cyclone Sidr in November 2007 and Cyclone Aila in May 2009 when the storm surge of 3 m (10 ft) impacted western regions of Bangladesh, provide recent examples of devastating storm-surge in Bangladesh (Hafizi N, 2011). Such frequent storms have brought much saline water inland and ruined the rice fields that people depend on for employment and food, and surface water. Frequent natural disasters mean that the traditional ponds or surface water bodies become inundated with sea water making these unsuitable for any form of human use. The people in Satkhira received the highest amount of sufferings from drinking water shortage soon after Aila attacked (Dasgupta, et al., 2011). Aila devastated all the drinking water sources (ponds and tube wells). High tidal surges, during the disaster, contaminated all fresh water sources with polluted saline water. According to newspaper reports, the fresh water crisis had intensified after cyclone Aila hit in 2009 when the polders in the coast were damaged and the region was submerged by saline water. District-wise Aila damage assessment of water infrastructure conducted by DPHE suggested that among the affected districts, the district of Khulna and Satkhira were the worst affected areas in terms of WatSan facilities where 278 PSFs were damaged. The situation was acute in Gabura union of Shyamnagar, Satkhira district where most of the drinking water sources were damaged. Many people were forced to drink such polluted water since they did not have any other option and consequently suffered from water borne diseases such as allergy, skin diseases, cholera and diarrhea (Learning and Knowledge Sharing Workshop on Response to Cyclone Aila , 2009).

It is found in most cases that the death toll caused by flood waters is measured in terms of initial drowning and trauma victims. However, the death toll does not plateau after the waters have receded. Waterborne diseases often wreak havoc on victims who have already suffered great loss. Clean water in most cases is far more essential than food after a disaster: the human body can survive for weeks without food but only for about three to five days without water. Unfortunately, flood victims often have no access to clean water, because of the destruction or absence of sanitation facilities, or problems with the distribution of water supplies. Worse, there is often general ignorance about the dangers of waterborne disease. All of these factors place survivors of floods at a great risk. As thirst becomes intolerable, a basic need of life becomes a hazard, and even people who are aware of the risk are compelled to disregard it because they do not know how to render water safe for use. For example, in the aftermath of the Bangladesh floods in 1998, 75% of the victims interviewed who drank from rivers or wells said that they believed the water was contaminated (Hafizi N, 2011).

Apart from impacts of natural disasters and climate change, safe drinking water scarcity is induced through other factors such as intrusion of saline water inland, water logging and lack of fresh water aquifers. Intrusion of saline water inland with less flow of water from upstream occurs especially during the dry season. This means that a significant portion of the south western coast is under stress in identifying suitable sources for drinking and irrigation water. According to the Soil Resources Development Institute, Ministry of Agriculture, about 62% of Bangladesh's coastal land has problems with salinity (Sarwar. M, 2005). This means there is a major shortage of clean drinking water, which has severe repercussions on the health of the people living along the coast. The situation has become worse with the introduction of shrimp farming and the consequent intrusion of brackish water far inside the coast which seriously affects ground water. As a result, groundwater is either brackish, absent or arsenic contaminated and so to gain access to a sweet water supply for drinking has become a question of survival.

Water logging, in addition, appears to be highly pronounced along the coastal rivers in the south-western region, where the adjoining lands are mostly empoldered. Often it is found that the drainage infrastructure such as sluice gates gets choked due to heavy sedimentation and eventually becomes inoperable. Once spillage takes place over an existing embankment, water does not find ways to recede, inundates agricultural lands, homesteads and surface water points.

The fresh water aquifers at reasonable depths are also not available. Such is the case in Satkhira district where the absence of saline-free safe drinking water is a mirage for people. Not only the tube well density there is rather poor (about 50 per cent with respect to the country average), most of the tube wells draw saline water, since ground water aquifers (even confined aquifers) have been found to be saline affected (Hafizi N, 2011). Moreover, many tube wells are sunk 300 feet below ground and a significant proportion of such tube wells draw water in highly reducing conditions (Learning and Knowledge Sharing Workshop on Response to Cyclone Aila , 2009).

Although, until recently, certain alternatives to collect safe drinking water were initiated by NGOs and government agencies, the solutions to mitigate salinity problems, treatment and prevention of saline water intrusion are not sustainable. In addition, demand of local communities for safe drinking water surpasses the number of fresh water points in the region causing immense water crisis. Lack of access to potable water poses threat to public health and security particularly to that of women and young girls. At present, coastal populations are mainly dependent on natural sources such as rain water and pond water for drinking purposes. There are few tube-wells in the pockets of deep aquifer which in most cases are hard to reach. Finding no alternative, many also use bacteriological unsafe surface water.

Currently, ponds with pond sand filter and rainwater harvesting at households and community level are the only major sources of safe drinking water (Dasgupta, et al., 2011).

Pond Sand Filter (PSF) is one of the popular options of potable water supply in coastal belt and arsenic prone areas. It has a slow sand filter unit to treat surface water, usually pond water for domestic water supply. The filter is installed near or on the bank of a pond. 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). The treated water from a PSF is usually bacteriologically safe or within tolerable limits.

In spite of widespread usage of Pond Sand Filters across the coastal region, which may be considered appropriate to the context of coastal areas where greater fraction of coastal population depend on pond waters and problems of salinity and arsenic contamination has limited safe drinking water sources, suitability of PSF may be reduced due to certain technical limitations. Like most filters, it requires maintenance at regular intervals and repairing, factors which can be difficult for locals and confront as obstacles towards sustainability of the technology. Community involvement in operation and maintenance is absolutely essential to keep the system operational. A formal institutional arrangement cannot be installed for running such a unit, community involvement in operation and maintenance is the key issue in making the system work. Although the program of PSF intervention, initiated by DPHE, was established in 1984, to utilize low saline pond water for water supply in the coastal area that could serve 200-500 people per unit, by June 2000, DPHE had installed 3,710 units of PSF, a significant proportion of which remained out of operation for poor maintenance (Learning and Knowledge Sharing Workshop on Response to Cyclone Aila , 2009). Moreover, many people complained of foul taste in pond water while others had conflict with fish culture. Many ponds dry up in the dry season and secondary contamination takes place due to lack of proper maintenance.

PSF is a low-cost technology with very high efficiency in turbidity and bacterial removal. Although PSF has very high bacterial removal efficiency, it may not remove 100% of the pathogens from heavily contaminated surface water. In such cases, the treated water may require chlorination to meet drinking water standards. In addition, salinity and iron content of the pond water should not exceed 600 ppm and 5 ppm, respectively, at any time of the year. PSFs, in most cases, are not disaster resilient (Dasgupta, et al., 2011). As in the case of Aila, due to tidal surge, storm water flown over the areas and all fresh water ponds got filled with brackish water from sea. The people simply lost sources of drinkable water and situation was getting worse due to lack of rainfall after Aila. Most PSFs malfunctioned; pond water became saline and contaminated. Further contamination was also caused by rotten fish that died due to entrapped brackish water and dead animals, leaves etc (Learning and Knowledge Sharing Workshop on Response to Cyclone Aila , 2009). Interventions of Pond Sand Filter still, however, in south western coastal areas have been carried out extensively through governmental and several non governmental institutions such as DPHE, Uttaran and Oxfam GB while in many areas; certain structural modification of the PSF is made to increase suitability of the technology in the region.

1.2 Objective

The objective of this study is to understand the suitability of pond sand filters (PSF) as safe drinking water solution in storm surge prone south western coastal areas in Bangladesh through identifying its limitations in the aspect of water quality, management and resilience towards disaster using sustainability indicators and learning from governmental and non-governmental organizations' experience on PSF intervention. The study is being conducted in Munshiganj union of Shyamnagar upazila, Satkhira district, Khulna, a south-western coastal region, which is the major disaster zone in terms of storm surge and salinity intrusion.

1.3 Limitation of the scope of the study

PSF, as suitable safe drinking water option, might not be appropriate in other storm surge prone areas due to different geography and geo-physical location, water sharing policies, availability of aquifers and adaptability of local communities to the system. As a result, sustainability indicators chosen for research area might change in context of others.

1.4 Significance and contribution of the research

The study will investigate suitability of PSF for safe drinking water solution for coastal habitants, which is currently a crisis in such disaster prone and saline affected areas. Such a study will not only reduce sufferings of communities particularly women and young girls in terms of security and health but also make the regions more livable for all.

CHAPTER 2: LITERATURE REVIEW

2.1 Geographical Location Context Analysis: Exposure to Recurring Hazards & Demand for Sustainable Safe Water Supply

2.1.1 Geography of Study Area

Khulna is the south-west division of the country with an area of 22273 sq km (see fig 1), (Dasgupta, et al., 2011) and is bounded by Rajshahi division on the north, Bay of Bengal on the south, Dhaka and Barisal divisions on the east and West Bengal on the west. The Ganges, Gorai-Madhumati, Ichamati, Kobadak, Shibsa, Kumar, Rupsa-pasur, Bhairab, Chitra, Raymangal and Mathabhanga are the major rivers that pass through the region. Satkhira is a district in South-western Bangladesh. Part of the Khulna Division, it lies along the border with West Bengal in India. Shyamnagar is an Upazila of Satkhira District in the Division of Khulna, Bangladesh. Shyamnagar Upazila is bounded by Kaliganj (Satkhira) and Assasuni upazilas on the north, Sundarbans and Bay of Bengal on the south, Koyra and Assasuni upazilas on the east, West Bengal of India on the west. The main rivers here are: Raymangal, Kalindi, Kobadak, Mother Kholpetua, Arpangachia, Malancha Hariabhanga and Chuna. Shyamnagar is regarded as the largest upazila of Satkhira district.

The upazila occupies an area of 1968.24 sq.km including 1622.65 sq.km of forest (Sarwar. M, 2005). Total 12 unions, named as Shyamnagar, Atulia, Bhurulia, Burigoalini, Gabura, Ishwaripur, Koikhali, Kashimari, Munshiganj, Nurnagar, Padmopukur, and Ramjannagar belong to the upazila.

2.1.2 Natural Disasters

Khulna is generally subjected to natural hazards such as flood, cyclonic storm surges, drought and tornado almost every year. In addition, the region has severe constraints due to certain unfavorable soil and land qualities such as salinity and water-logging. Also included are a plethora of hydro-geo-morphological hazards which include poor drainage through its river systems, high rates of sedimentation on river beds, acute low flow conditions during the dry season, salinity ingress along the rivers, moisture stress in the dry season, rise in sea level, and to a lesser extent, and flood. While Khulna located in the coastal zone and Shymnagar lying in the exposed coastal zones of the country, these regions are significantly influenced by tidal effects. According to available statistics on Coastal Zone, majority of the

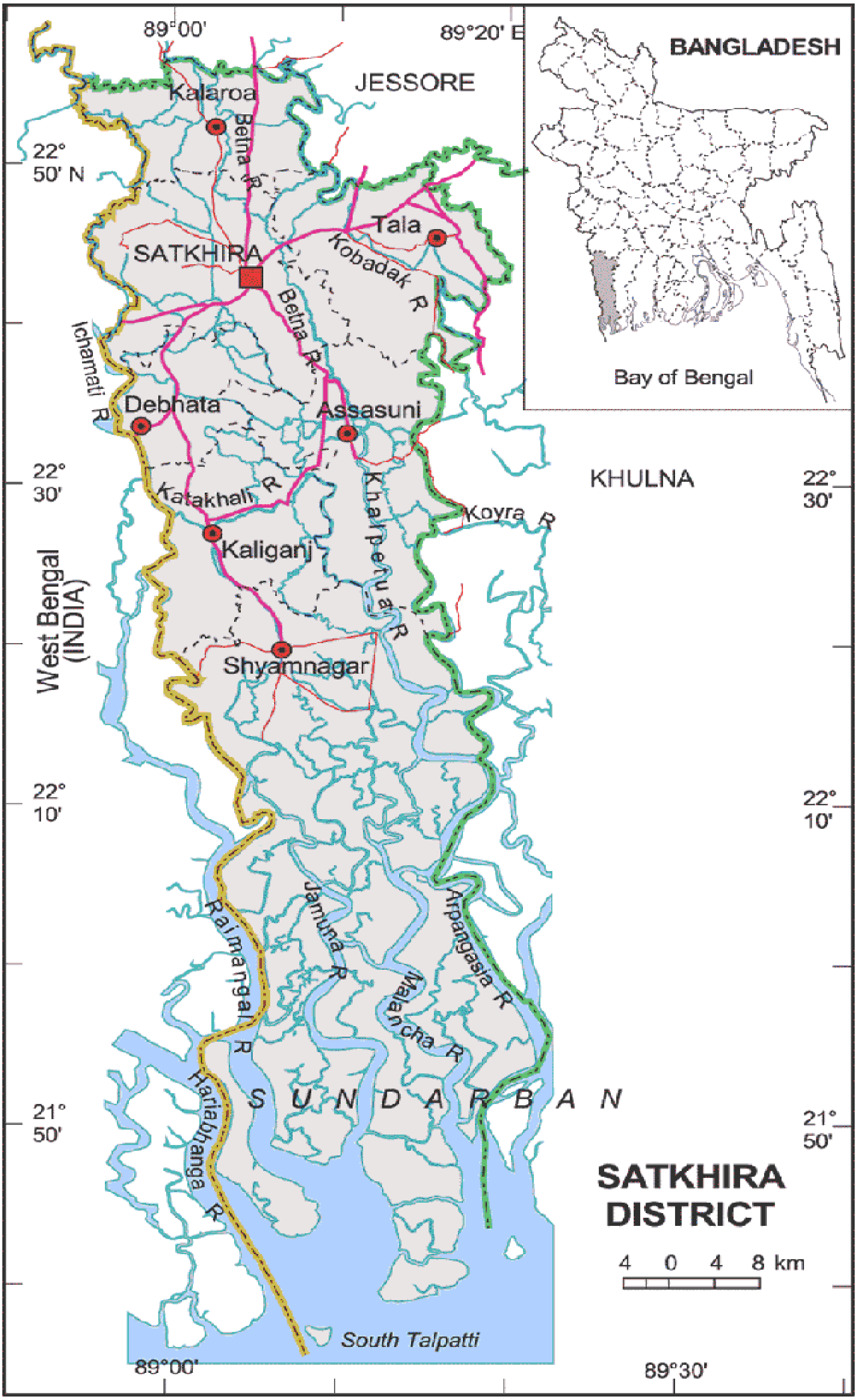

Figure 1 Map of Khulna, Shatkhira District

land is within one meter from mean sea level, a significant proportion of which again falls below high-tide level.

Over the past few years, natural disasters in this south western region have become more frequent and devastating. After the flood in 1998, there was another inundation in 2004 that flooded about 2/3rd of the country including the dry & drought prone south-western regions and affected in total more than 30 million people and destroyed around 2 million acres of crop land (www.dmb.com). In October 2008, the southwest coast was hit by Cyclone Rashmi, and in November of the same year Cyclone Sidr, a category four super cyclone, hit the south and south-west coast causing extensive damage and the loss of over 4,000 lives. Cyclone Sidr devastated around 4 million families and displaced 6 million people (Sarwar. M, 2005). According to unofficial sources, Sidr claimed over thousands of lives in Southkhali union under Sharankhola upazila of Bagerhat of Khulna while thousands of families in the area near the Baleshwar River were rendered homeless by tidal surges.

In 2009, cyclone Aila , the category 1 cyclone, hit South-Western coastal region of Bangladesh on 25 May 2009 and affected 1 million people, displaced around 2 lakh, damaged embankment and 6393 acres of crop fields with saline water (WorldWide, DanChurchAid, MuslimAid, Relief, Oxfam-GB, & Children-UK, 2009). Cyclone Aila affected an estimated 3.90 million people in 11 coastal districts of the Bangladesh's 64 districts. About 2.3 million people were affected by Aila and many of them stranded in flooded villages as they had no alternative to save themselves. More than 5 lakhs people were alone affected in Satkhira district of Khulna division. Even though Aila was a weak category cyclone by definition, its economic cost outweighs the impacts of Super cyclone 'Sidr' and brought in long-term sufferings for the southwestern people of Bangladesh. The impact was aggravated as the cyclone hit Bangladesh during the high tide cycle that resulted to tidal surges of up to 22 feet. The surge of water caused portions of the embankments to collapse and people who believed that the embankments could protect them did not have enough time to evacuate to higher and safer ground. During Cyclone Aila, the storm spent more time over-land than Cyclone SIDR in 2007, lingering over the coast of Bangladesh and increasing its impact on the vulnerable villages. Over 50% of displaced people (more than 200,000) are still living in the same condition in severely affected Khulna and Shatkhira District (Dasgupta, et al., 2011). The devastations left by Cyclone Aila still remain chronic till date jeopardizing the livelihood patterns and settlements in the area.

The Cyclone Aila furiously hit the Satkhira and Khulna Districts of Bangladesh (see fig2 & 3), entrancing immediate death of about 325 people including massive infrastructure damages. Among the affected districts, Satkhira receives the highest amount of impacts in its infrastructures including educational institutions, religious institutions, roads, bridges, embankments etc. 734 institutions were damaged and the adverse impacts of Aila were observed in 7 Upazilas and 48 unions of Satkhira District of which Shyamnagar and Ashasuni were the most affected Upazila (Concern WorldWide, DanChurchAid, MuslimAid, Relief, Oxfam-GB, & Save the Children-UK, 2009).

Shyamnagar is the perfect epitome of Aila ravage as it was most vehemently seized with Aila attack. Besides the accounted damage, a large number of households and small infrastructures were damaged. In only Gabura and Padmapukur union, more than 34 thousand people became homeless and it was estimated that among 59 deaths in the upazila 28 were from Babura, 10 from Padmopukur, 15 from Burigoalini, Ishwaripur and Munshiganj, and 6 from Koikhali and Kashimari union (www.dmb.com).

2.1.3 Demands for Safe Sustainable Water Supply

As already mentioned, the geo-physical location of Shymnagar Upazila in Satkhira district, it being located in the external coastal areas of the country, contributes greatly to the recurring natural hazards. Additionally, effects of climate change has reduced return period between each calamities and magnified the resulting devastations. Finally the structural developments such as that of coastal embankments of the 1960's, which was built to increase agricultural production and to protect human settlements and crops from tidal surges, decreased the depth of the estuaries and tidal prism with time (Concern WorldWide, DanChurchAid, MuslimAid, Relief, Oxfam-GB, & Save the Children-UK, 2009). Salinity has gradually increased due to the capillary action resulting in reduced fertility of agricultural land and drying of rivers due to the increasing levels of silt on their beds. The presence of salt water in the rivers upstream of the estuaries makes the use of groundwater near the river problematic, as there is a risk that salt water will be drawn into the aquifer. The sea level of this region is raising 3-4 ml per year and it creates new salinity affected areas, which creates further scarcity of drinking water (Sarwar.M, 2005). Moreover, the conversion into unsustainable livelihood of shrimp cultivation is another driving factor to increasing salinity levels. Shrimps are farmed using saline water piped from rivers which not only increases salinity of local water bodies such as ponds and wetlands but can also seep and contaminate drinking water.

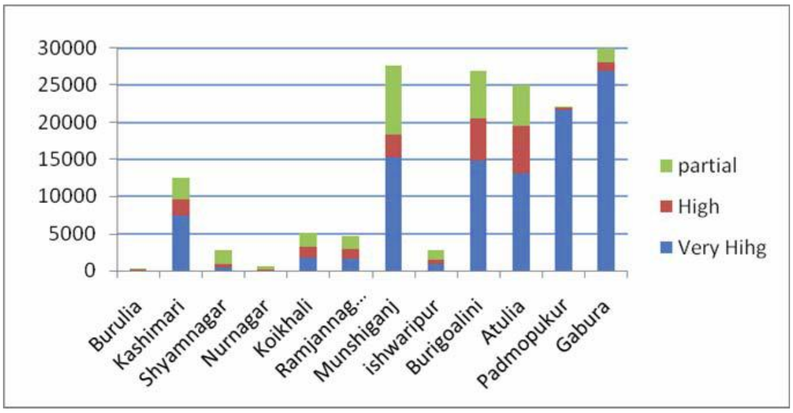

Figure 2 Affected population at different unions of Shyamnagar Upazila

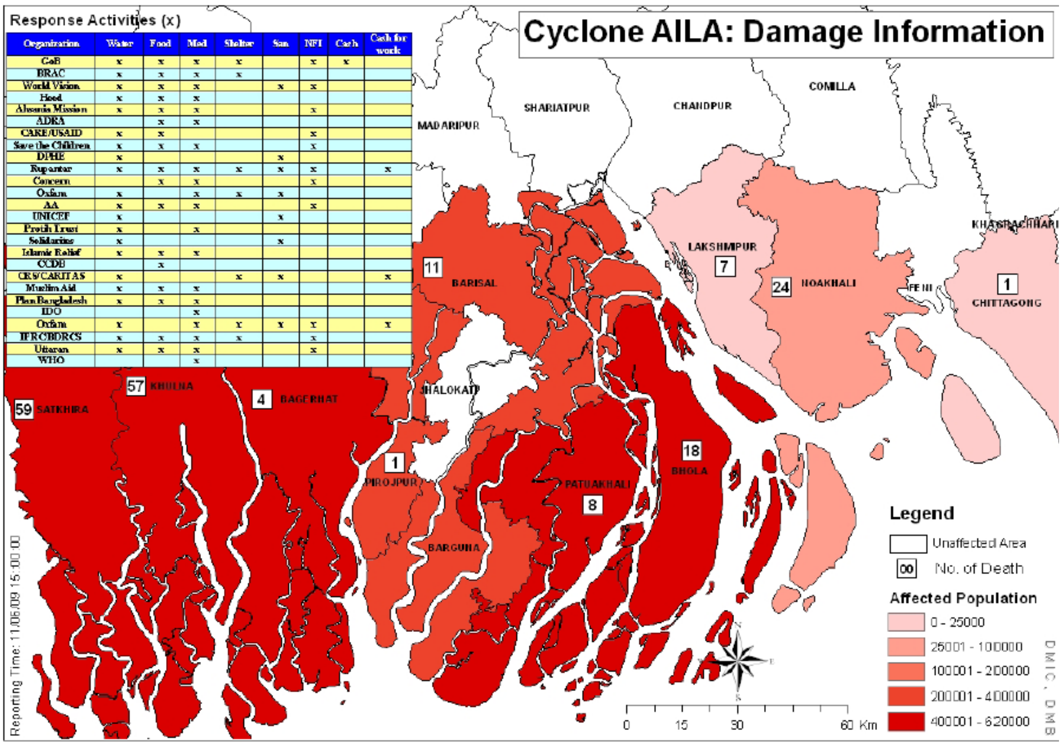

Figure 3 Aila Affected Areas in the Coastal Regions of Bangladesh

The frequent disasters bring saline water inland polluting surface and fresh water points. During cyclone Aila, for instance, the people in Satkhira suffered greatly due to drinking water shortage. All drinking water sources such as ponds and tube wells were flooded with high tidal surge. According to district-wise Aila damage assessment of water infrastructure conducted by DPHE, the situation in Gabura union of Shyamnagar, Satkhira district was grave in terms of water facilities (Sarwar.M, 2005). With most tube-wells flooded, many were forced to drink polluted water since they did not have other options and consequently suffered from water borne diseases such as allergy, skin diseases, cholera and diarrhoea.

2.2 Safe Drinking Water Solution in Coastal Areas of Bangladesh

2.2.1 Lack of Safe Drinking Water in Coastal Areas: Causes and Effects

Lack of access to safe drinking water is an impediment to improving health conditions and wellbeing and reducing poverty in southwest coastal regions of Bangladesh. The main causes of drinking water scarcity are salinity in ground and surface water, arsenic contamination of shallow aquifer, shortage of ground water or lack of aquifers, water-logging and natural disasters. The causes of drinking water scarcity result in negative health, social and economic outcomes for coastal population.

Causes of Lack of Safe Drinking Water

i. Arsenic Contamination

Underground water of south-western region contains arsenic. A study carried out by a local NGO indicated that 79% of the tested tube-wells of the area contained arsenic beyond the acceptable limit (http://pravdabangladesh.wordpress.com/access-to-safe-drinking-water/). Most of the shallow tube-wells in the region draw either brackish water or arsenic-contaminated water.

ii. Lack of aquifer

Ground water occurs in permeable geological formations known as aquifers. For extraction of groundwater medium clean sand is suitable. This sand has considerable porosity and permeability and can store a huge amount of water. Fine sand also can store a considerable amount of water. However, as the position of the area is in the lower part of Ganges delta the sediments of the region have very low permeability and are not able to store water. As a result, the region lacks aquifer that fresh groundwater can be extracted from.

iii. *Cultivation of brackish water shrimp*

In the southwest region shrimp cultivation is underway in almost all the wetlands. In most of the cases, salt water from the river is brought into the wetland for shrimp cultivation, which is increasing the salinity of the adjacent fresh water ponds and shallow aquifer through seepage (WorldWide, DanChurchAid, MuslimAid, Relief, Oxfam-GB, & Children-UK, 25-31 October 2009).

Thus there is great scarcity of drinking water in areas where shrimp is cultivated and that covers greater portion of southern districts of this region. This shortage of drinking water affects women the most, as it is their responsibility to collect drinking and cooking water for the household. They have to walk several kilometers to obtain drinking water, wasting much of their time that they could have used in productive employment.

iv. *Reduction in upstream flow*

In the past the southwest coastal region was rich in fresh water as the Ganges had flowed through it. However, the scenario changed following two disastrous events: the change of the course of the river Ganges due to Ganga water distribution Treaty, commonly known as Farakka Treaty due to which only 27500 thousand cusec water becomes available for Bangladesh during the dry period with the remaining amount being diverted by India) and the closing of the face of the origin of the river Matha Vanga ((http://pravdabangladesh.wordpress.com/access-to-safe-drinking-water/)). This had a serious implication for safe drinking water available from ground water sources. The reduction of upstream flow deteriorates the recharge rate of the ground water table, reduced fresh water bodies and results in over extraction of groundwater for irrigation and use of water from fresh water ponds.

v. *Excessive use of underground water in an unplanned way*

Since the 1980s vast land in the southwest coastal region, except the slight saline wetland, has been brought under irrigation for cultivation of Boro rice through extraction of underground water in the dry season (Hafizi N, 2011). The lack of surface water for irrigation during dry season has compelled the farmers to exploit underground water extensively resulting in a lowering of underground water table beyond the suction limits of shallow tube-well, making millions of shallow tube-wells dysfunctional. This over-extraction of groundwater is one of the possible reasons for the contamination of shallow aquifer by arsenic.

vi. Natural disasters

Due to geographical disadvantage, this southwestern region of Bangladesh regularly experiences natural disasters (e.g. water logging, cyclones, tidal surges, floods, river erosion, etc) which are responsible for the destruction of drinking water sources. In addition, effects of climate change have caused hazards in this region to occur more frequently than before and with greater intensity. During cyclone Sidr in late 2007 the majority of drinking water sources became dysfunctional. Under the Sidr rehabilitation programs water supply and sanitation facilities were restored by various government and non government agencies. However, the majority were again damaged by the recent cyclone Aila (Dasgupta, et al., 2011).

Gabura is one of the victim union of Shyamnagar where most of the drinking water sources damaged during cyclone Aila. The people of the area received the highest amount of sufferings from drinking water shortage. Aila devastated all the drinking water sources (ponds and tube wells). During Aila, high tidal surges contaminated all fresh water sources with polluted saline water. Many people were compelled to drink such polluted water as they do not have any other option and consequently suffer from water borne diseases such as allergy, skin diseases, cholera and diarrhea. The sea level of this region is raising 3-4 ml per year and it creates new salinity affected areas, which creates further scarcity of drinking water (Hafizi N, 2011).

Effects of Lack of Safe Drinking Water

The effects of scarcity of safe drinking water in south-western region can have health, social and financial implication. People in the region suffer from various diseases caused by drinking an insufficient amount of water and drinking water with high levels of salinity, impurity or arsenic contamination. Various skin diseases, intestinal diseases, dysentery, fever and diarrhea are part of life. Other health concerns linked to a lack of safe drinking water include malnutrition amongst women and children, reproductive problems for pregnant women, skin turning black, physical weakness and anxiety. Women can be particularly susceptible to diseases (e.g. rickets) as they are expected to take less water than men.

Women and girls face a number of rights abuses as a direct result of the lack of safe drinking water. In rural Bangladesh it is the women's role to collect drinking water. The drinking water can be many kilometers from the home and there are frequent incidents of violence against women and girls for not fetching drinking water on time or not having meals prepared because of the amount of time it takes to fetch water. Fetching water means women do not have time to tend to their homestead garden, which is often their only source of productivity and income.

There are other social crises associated with poor access to safe drinking water: the education of children is hampered; young children are often left unattended when their mother goes to fetch water; they are frequent incidents of child labour; the household has less time to socialise and develop social networks; women are teased and harassed on their way to fetch water; social stigma prevents girls getting married and leads to an increased rate of divorce; population migration; and local contentions and litigations related to water use have become a regular phenomena.

Gathering drinking water means a significant amount of productive hours is consumed. Household expenditure increases to purchase fresh water to enable cultivation of crops. Cost of buying vegetables increases whilst the durability of houses is reduced and scarcity of food occurs. Maintaining livestock and poultry become difficult. Scarcity of organic fertilizer makes carrying out agricultural activities difficult. All these factors together constitute a major economic problem for the poor.

2.2.2 Safe Drinking Water Options

According to the paper "Solution Exchange for the Climate and Disaster Risk Reduction Community Consolidated ReplyQuery: Safe Water for the South West – Experiences; Advice Compiled by Dilruba Haider, Community Facilitator and Shibaab Rahman", which seeked inputs as a part of CDRR Community from officials of various NGOs such as SPS Khulna, ActionAid, UNICEF and DPHE and Government such as CDMP to receive their experiences and lessons learnt on supplying drinking water and sweet water for irrigation in the region, provided insights on existing technologies. These technologies which include both low-tech/low cost and high-tech/high cost drinking water solutions have been implemented by governmental and various non governmental institutions in the coastal areas of the country.

Low-Tech/Low-Cost Drinking Water Solutions

i. Rain Water Harvesting

The most common low-tech and low cost technique used by communities is rainwater harvesting (RWH). Rain water harvesting has been modified through different non governmental organizations to provide the needy at affordable costs so as to harvest rain water for drinking purpose. According to the paper, SPS Khulna, for instance, set up concrete tanks which is used as the RWH, costing Tk 15,000 per family while some local earthen containers (namely motka) that cost individual families Tk 1,000. Action Aid installed a RWH system in Khulna, while UNDP’s Disaster Response Facility set up rainwater harvesters in areas affected by cyclones AILA and SIDR. According to the paper, the RWH was intervened in western Indian state of Guujrat that helped improve the ground water table.

ii. Excavating or Renovating Ponds

Excavating or renovating ponds on higher ground is another means of producing an access to sweet water for drinking purpose through building strong and high embankments. The Bangladesh Disaster Preparedness Center (BDPC) used this solution in Morrelganj of Bagerhat district, where they re-excavating some derelict ponds.

iii. Pond Sand Filter

This is an alternative and popular option of potable water supply through treatment of surface water in coastal belt and arsenic prone areas for providing domestic water supply. Intervention of PSF by UNICEF and the DPHE was carried out along the coastal belt; however, lack of maintenance caused them to be abandoned. According to the paper, PSF could offer a good solution, if maintained properly. The structure, function and management of PSF are discussed in details later in page 19.

iv. Rooftop Catchment Areas

“Rooftop catchment areas are set up in roves of homestead and were intervened by Comprehensive Disaster Management Program (CDMP) with DPHE, some of which were implemented in Satkhira”, the paper explains.

v. Plastic sheets with a hole

During disasters, many NGOs provide plastic sheet with a hole to collect rain water when scarcity of water is high. The plastic sheet with a hole in the middle is set by spreading it on four bamboo poles or on thatched roof to collect rainwater.

vi. Shallow and Deep Tube-wells

As per the document, shallow and deep tube-wells generally extract ground water from aquifers with depth of 300ft and 1000 ft respectively. Various NGOs and Government of Bangladesh have implemented such tube-wells in different regions of coastal areas mostly as temporary solutions.

High-Tech/High-Cost Solutions

i. Solar Powered Desalination plants, Reverse Osmosis (RO) and nanotechnology

High tech and high cost drinking water solutions were also looked at. Solar Powered Desalination plants and Reverse Osmosis (RO) machines are both options to reduce the salinity of the water. One of the local NGOs installed four RO machines along the coastal region, which treat saline water and produce pure drinking water. Members expressed some reservations about this, due to the high set-up and maintenance costs associated with this technology. In an effort to make, it more cost effective and efficient, the literature highlighted the use of nanotechnology - carbon nanotubes (CNT). CNT is a filtering agent that RO desalination machines can use, which can significantly reduce the cost of RO plants.

ii. Others

Some other very expensive options like ‘sky water harvesting’, ‘air to water’ technology (collecting water from vapor), membrane-based water technology, and piping water in from areas that have sweet water sources. All of these options have very high installation costs, but because of the long term usage without any further investment, makes these options worth considering. In Shyamnagar of Satkhira district, Shushilan along with Dhaka University are piloting an initiative that drives rainwater to shallow pockets of aquifer to recharge ground water, which is then drawn through a tube-well.

2.2.3 Advantages and Challenges of Drinking Water Options and Current Situation

As already discussed, the commonly used water drinking options in the study area are low cost technologies shallow and deep hand tube-well, sweet water protected ponds, Pond Sand Filter (PSF), Rain Water Harvesting along with certain high cost technologies such as Household Desalination Unit (Piloting). However, all water systems comprise of advantages and disadvantages that make it unsustainable and unusable during or post disaster.

Deep and shallow hand tube-wells are easy to use, cost efficient and highly accepted by users. However, they can be flooded during disaster if not raised and become non-functional. In addition, shallow hand tube-wells and in many cases, deep hand tube-wells, draw arsenic water as water aquifer falls and is not always effective due to high salinity. Sweet water Protected Ponds water can be used for drinking and cooking and prevents saline intrusion due to raised embankment and preserves sweet water source. Then again, water from sweet water protected ponds needs to be treated with alum or boiled to improve water quality as the embankments of the ponds needs constant monitoring to make necessary repairing. Many unknowingly use the water for bathing, washing while other intend to cultivate fish using fertilizer and other activities which can be a threat to health hazards. PSFs can provide bacteria and saline free water which is also less turbid and quality of water is better than pond water but it too requires constant monitoring and repairing. This technology can be built to serve a large community. Use of this technology induces community cooperation in the provision of safe drinking water supplies. In case if ponds dry out, PSFs may not be usable due to less availability of water. And although RWH can store sweet water that is bacteria and saline free, it can not provide water year round. Additionally, roves and containers have to be constantly cleaned. Rain water also contains fewer minerals as a result many prefer not to drink it. Others such as Solar Power Operated Submergible and Surface Water Pumps to Extract Water from Ponds and Boreholes are a high cost technology which, however, are not manual and provides abundant supply of water to various communities through piped network. Household Desalination units and Reverse Osmosis which are at piloting stage provide bacteria free water but are highly expensive.

However, according to most literatures, considering the geo-physical location of coastal areas where salinity intrusion is prominent, affecting mass population and fresh water points limited and taking into account ‘sustainable safe drinking water solution’, Pond Sand Filter is considered most suitable of all the safe drinking water options in coastal areas of Bangladesh.

Current Situation

According to news report in Daily Sun, after the devastating cyclone Aila that hit the coastal belt in May 2009, most of the people in the areas still do not have access to sufficient quantity of drinking water as the cyclone damaged most of the sources of water. In the Aila-hit areas, tube-well is not successful due to the presence of high salinity in the shallow and deep aquifer level. Ponds with pond sand filter, reserving rainwater in households and community level are now the only major sources of safe drinking water. After two years of the cyclone, approximately 34 percent of households (108,415 people) still do not have access to sufficient quantity of safe drinking water as reported by Oxfam's Bangladesh office.

Local sources said although the government and non-government organizations (NGOs) have already taken a number of measures to address the water crisis, these are still not enough to meet the demand of a large population in the Aila-hit areas. Most of the rivers, canals, ponds and wetlands in the coastal belts particularly Mongla in Bagerhat, Dakope and Koira upazilas in Khulna, and Shyamnagar upazila in Satkhira district are heavily affected by salinity intrusion. Locals said only very few people have the ability to buy purified water from different water treatment plants or shops, but most of the people could not afford to buy safe drinking water due to financial crisis. Most of the villagers in remote areas have to collect drinking water from distant places.

As per the newspaper report, in the past, villagers used to collect drinking water from nearby water ponds as was the case in the village of Tolma under Dumuria upazila in Khulna. Most of the villagers now depend on tube-wells as the ponds have been contaminated due to salinity intrusion that however is not adequate for them. Surface water as pond water is put in use as drinking water option in many other areas. A water treatment plant has been set up by Prodipan, a local NGO, at Mongla Upazila Parishad Jame Mosque in Bagerhat district in Khulna division. At present, the plant purifies 3,000-4,000 liters of salt water taken from a nearby pond.

Government took limited steps with food aid and to pump out saline water from ponds at least one or two from each village with a plan to harvest rain water for domestic use. Embankments were not fully repaired due to inundation of saline water in vast land areas, so pumping out of saline water could not reach every village. People of AILA affected areas used to drink and cook with surface water from pond and Pond Sand Filters (PSF) constructed by the Department of Public Health Engineering (DPHE) of the Government. DPHE has 189 PSF and community pond spread over 12 affected Unions of Shyamnagar

Upazilla of Satkhira district. GK has cleaned 172 identified ponds with the deployment of 16 water pumps from Gonoshasthaya Cooperatives and 6 water pumps organized by local NGO for cleaning debris (WorldWide, DanChurchAid, MuslimAid, Relief, Oxfam-GB, & Children-UK, 25-31 October 2009).

2.2.4 Pond Sand Filter: Structure, Functions and Management

Pond Sand Filters can serve as many as 300-500 users per unit with quality water that is better than pond water. The water it supplies is less turbid and bacteria free. The PSF is a low-cost technology and has received preference as an alternative water supply system for medium size settlements in arsenic affected areas and coastal areas. The technology is very well adapted to areas such as coastal areas which are not feasible for DHTW installation due to hard layer or non availability of suitable aquifer producing acceptable quality and quantity of water; where the shallow aquifer is contaminated with arsenic or existence of excessive salinity in the ground water; where there is no available safe water sources and where the sources are far from the users households.

In another literature, members of the paper "Solution Exchange for the Climate and Disaster Risk Reduction Community Consolidated Reply Query: Safe Water for the South West – Experiences; Advice Compiled by Dilruba Haider, Community Facilitator and Shibaab Rahman" felt that PSF could offer a good solution, if maintained properly. It mentioned that many PSFs are partially or completely damaged by the tidal surge. Therefore, it is important to make structural modification of existing PSFs to ensure supply of safe water in the region after such disaster. According to the writers, effort can be made to elevate the platform and bed of existing PSF at a safe height above probable tidal surge level which could prevent entering brackish water into the structure during disaster. Adaptation of such model could turn many existing PSFs including fresh water ponds into sustainable sources of water during and after disasters. In many areas, existing PSF has been rehabilitated and a new PSF of larger capacity has been demonstrated. Regular operation and management mechanism of the pond and PSFs has been ensured by paid caretakers under the supervision of management committee. New design of PSF has been experimented by an international NGO and a local NGO having four taps with wider platform having larger capacity. Promotion of PSF with this design will contribute to utilize scarce resource- safe water in the coastal belt and facilitate women and girls to save time for water fetching. Cost of such larger capacity PSF will be slightly higher than the traditional PSFs whereas production capacity is almost double.

Other modifications have been made to regular PSF in many areas to reduce its limitation and increase its efficiency. Another filter namely combined filter consists of roughing filters and a slow sand filter. The PSF, however, cannot operate effectively when the turbidity of surface water exceeds 30 mg/l. The low discharge and requirement of frequent washing of the filter beds are common in Bangladesh. This is due to high turbidity and seasonal algal bloom in pond water. The situation is improved by making modifications particularly by the construction of roughing filters for pretreatment of water. The roughing filters remove turbidity and color to acceptable level for efficient operation of the slow sand filter installed in sequential order following roughing filters. Operation and maintenance are relatively easy and less frequent attention is needed for longer duration of operation between cleaning. A combined unit of such filter has been constructed in Samta Village in Jessore district by Asian Arsenic Network (http://phys4.harvard.edu/~wilson/arsenic/conferences/Feroze_Ahmed/Sec_3.htm).

To prevent entering of brackish water into fresh water pond by the high tidal surge during disaster, a durable solution has been experimented by WaterAid Bangladesh and Shushilan by raising embankments of the ponds to a height above the highest tidal surge. While doing so, a guide wall has been erected as a protection measure ensuring adequate compaction of the bank with a turf-topped wide passage around the pond. Existing PSF has been rehabilitated and a new PSF of larger capacity has been demonstrated. Participation of the community and local government institution is an important aspect. Regular operation and management mechanism of the pond and PSFs has been ensured by paid caretakers under the supervision of management committee (Sarwar. M, 2005).

Structure of Pond Sand Filter

It is an alternative and popular option of potable water supply in coastal belt and arsenic prone areas is the Pond Sand Filter (PSF) (see fig 4 and 5). It is a package type slow sand filter unit developed to treat surface waters, usually low-saline pond water, for domestic water supply in the coastal areas (http://phys4.harvard.edu/~wilson/arsenic/conferences/Feroze_Ahmed/Sec_3.htm). Slow sand filter is installed near or on the bank of pond, which does not dry up in the dry 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). The main filter chamber consists of a layered, sand filter bed, through which the water trickles and in which impurities, including bacteria, are removed in a manner similar to slow sand filtration. The quality of the raw water is further protected through the reservation of the ponds feeding into the filtration system solely for potable water use. A more advanced and commonly used PSF are the ones that bear three set of chambers including a roughing filter. The water from the tube well is pumped into the sedimentation chamber from which it seeps into the roughing filter bed in the next chamber (see fig 6 & 7). This chamber comprises of a perforated filter bed through which the water trickles upward and passes through the roughing filter bed comprising of large coarse sand. The water then overflows into a third chamber that is composed of finer bed of sand particles. The filtered water is then piped into the storage chamber from which it is connected to outlets and taps outside.

On average the operating period of a PSF between cleaning is usually two months, after which the sand in the bed needs to be cleaned and replaced (Sharmin, F, 2010)¨. The average life of a PSF is a minimum of 10 years.

Suitability

This technology is suitable for use in areas where there is adequate (seasonal) rainfall. In Bangladesh, the use of this technology is limited to those areas lacking access to adequate groundwater sources which can be accessed using tube-wells are found to be successful in the location. In the areas where PSF systems have been developed, tube-wells are not successful as suitable fresh water aquifers are not available at reasonable depths. Groundwater is saline down to depths of 200 m to 350 m, and naturally-occurring surface water sources are saline and also polluted.

There are two types of PSF, one of which is Model - 1 (PSF-300) that is feasible for 300 users. However, if the pond water is very turbid, Model-2 (PSF-500) may be required even for users less than 300. Model - 2 (PSF-500) is generally constructed for 500 users (Sharmin, F, 2010).

The program for installing of PSFs was first initiated by DPHE with the construction of 20 experimental units in 1984 to utilize low saline pond water for water supply in the coastal area. There are no privately produced PSFs in Shymnagar. Currently, there is a total of 398 PSFs altogether in the 12 unions with a total coverage of 121000 (Sharmin, F, 2010).

Pond Sand Filters in Shymnagar: Coverage, Use by Communities and its Management

In Bangladesh, numerous Pond Sand Filters have been constructed. About 90 PSFs, each serving about 50 to 60 households on the average, have been constructed in Dacope thana since the start of the PSF programme in 1984. In Kaliganj thana, there are about 24 PSFs, all constructed during 1993-94 (Sarwar.M, 2005). The use of PSFs has the potential to revolutionize the drinking water systems in the saline areas in the southern belt of the country, covering the Greater Khulna, Patuakhali, Barisal and Noakhali districts. Only in Gabura of Shyamnagar in Satkhira, 23 PSFs are constructed after Aila.

Operation and maintenance requirements of PSF relate primarily to the hand pump used to transfer the water from the ponds to the filtration units. The expenses associated with this are bore by the community. Initially, the Bangladesh Department of Public Health Engineering (DPHE) or local NGOs supplies necessary tools to the caretaker family to maintain the pump as required, and the users make minor repairs themselves. If major repairs are needed, and the related maintenance expenses are large, the community can apply to the DPHE and local NGO for assistance. Operation of the PSF pump is generally maintained by the users who pump and filter enough water for their own use.

Routine cleaning of the PSF is required. The rate of filtration gradually decreases over time, with the length of run resulting in increasing head loss. In order to maintain a constant rate of filtration, the height of water above the sand bed can be increased; however, a time will come when the filter bed must be cleaned to restore a reasonable rate of filtration. When the turbidity of the pond water is less than 8 NTU, the usual time between cleanings is about five months. When the turbidity increases to 30 NTU, it may be necessary to clean the filter every one and half months. The length of run also depends on the number of users drawing water from the system. Cleaning of the PSF is very simple and can be accomplished by two persons in under 45 minutes.

Adoption of this technology is at the community level. In Bangladesh, prospective users of this technology apply to the Department of Public Health Engineering (DPHE) for technical assistance, acknowledging their willingness to build and operate a PSF. This undertaking is a willingness not only to transport the required materials to the site from pick-up points, but

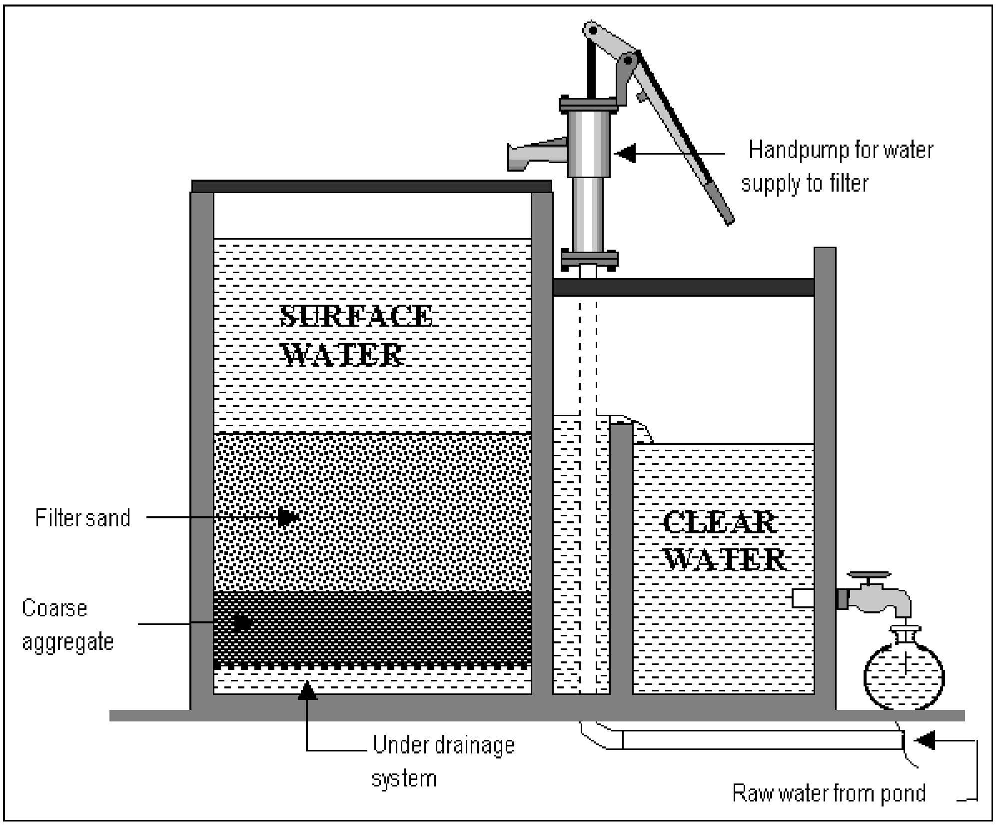

Figure 4 A Pond Sand Filter

Figure 5 Pictures of Pond Sand Filter

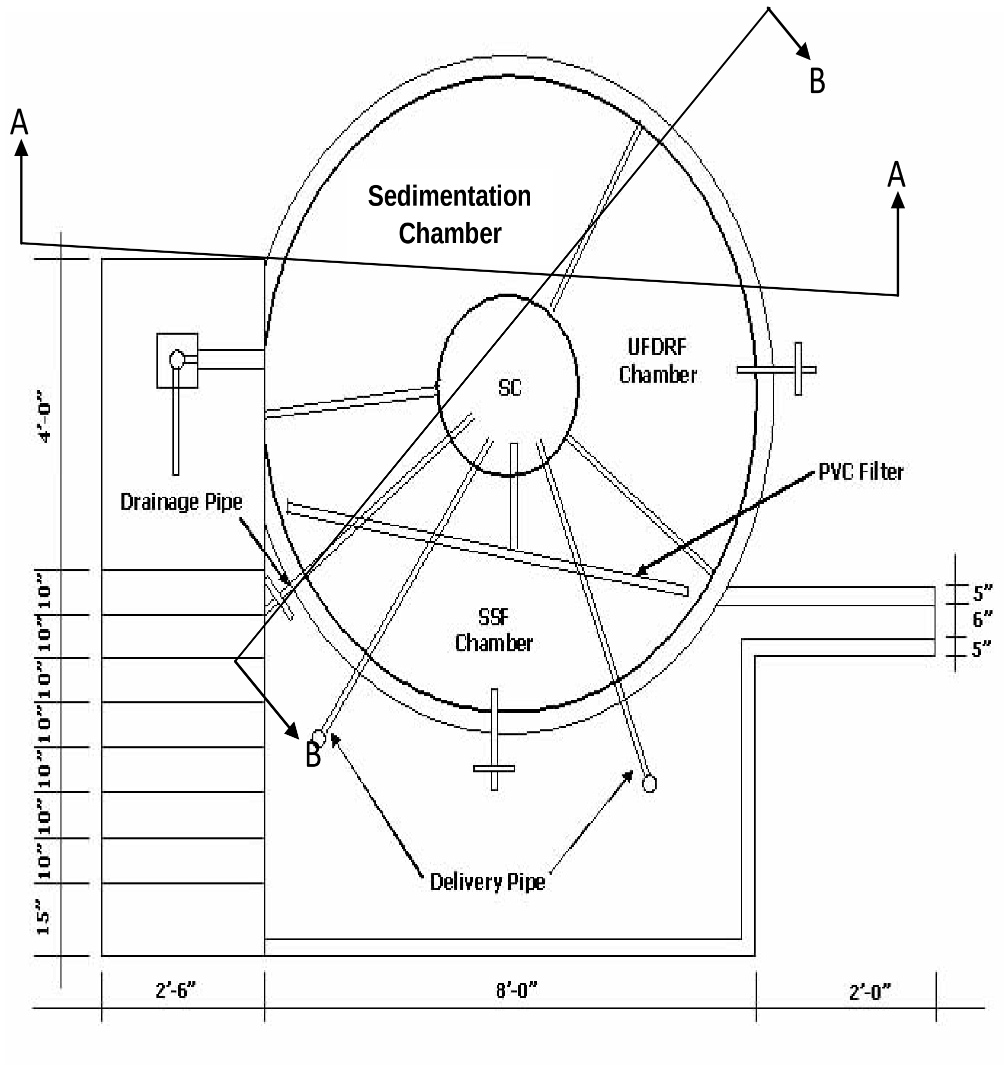

Figure 6 Pond Sand Filter (with three chambers) cross sectional overview

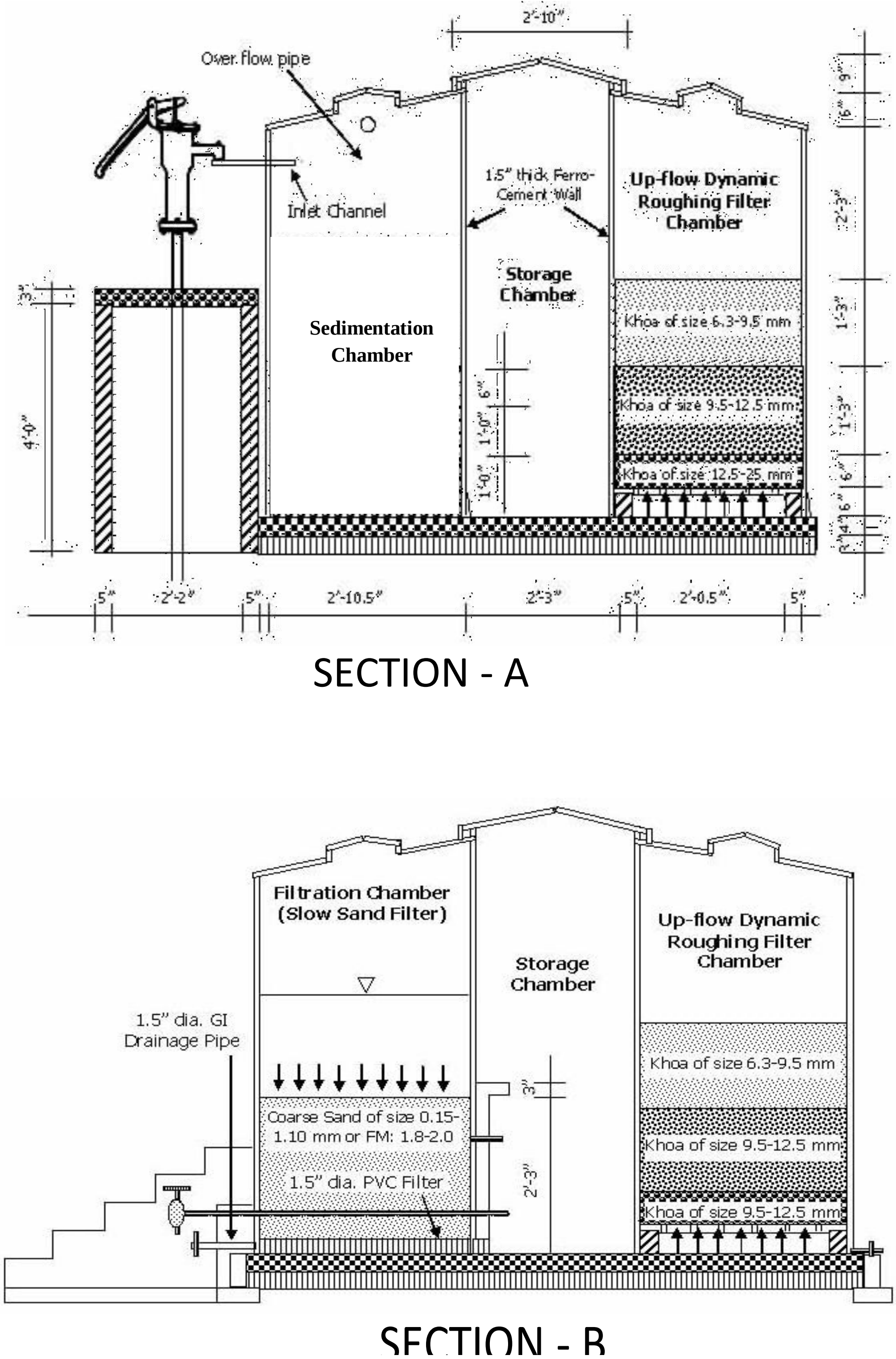

Figure 7 Pond Sand Filter cross-sectional view from side

also to provide labour. Brick-makers, as well as a mason, plumber and carpenter, are provided by the community as needed during the construction of the PSF system. The community also nominates two men and two women (caretaker families) to be trained in the maintenance of the PSF when it is handed over to them by the DPHE or other NGOs. The community then takes full responsibility for the cleaning, maintenance and repair of the PSF. The PSFs in Bangladesh cost about $ 1 500 each to construct, depending on size. This cost is currently met to varying extents by the DPHE and other NGOs, depending on the degree of need within the community.

2.3 Summary

In addition to the recurring natural hazards that are induced by the geographical setting of the south western region of the country, intrusion of saline water over time, water logging as a result of embankments, shrimp farming and falling ground water aquifers are all factors leading to reduced availability of safe drinking water sources. In response government and a number of NGOs have had water interventions that included both low cost and high cost technologies. Commonly water systems such as tube wells, rain water harvesting and PSFs are used as primary drinking water sources while high cost tech such as Reverse Osmosis and Solar Powered Desalination units are either installed for piloting or are just options discovered. Since the very beginning, the people in this area were dependent on pond water; Pond Sand Filter provided a suitable solution. Pond Sand Filter a slow sand filter where water from the ponds is manually operated using a tube-well and the water is treated over filter beds to remove impurities and bacteria. Taps are connected at the outlet for receiving safe drinking water by users. Its maintenance and necessary repairing is bore by communities although in case of larger technical difficulties, they may apply to DPHE or local NGOs for assistance. Suitability of PSF, however, is reduced as a result of reduced maintenance and resilience towards disaster. After Cyclone Aila hit in 2009, around 278 PSFs in just Gabura union of Shyamnagar upazila became non-functional due to inundation of PSF ponds with saline water. Despite the drawback, PSFs are still being extensively constructed across the south-western region both by government and NGOs and structural modifications are being made to increase efficiency while its suitability in the area is not being correctly assessed.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Research Method

The techniques and tools employed to complete the research are based on both secondary and primary sources which are discussed in details in the following.

A. Literature Review

Literature review included reviewing secondary documents most of which are publications from NGOs along with articles and journals from websites. The publications collected focuses on the intervention of pond sand filters in storm surge areas, functioning of PSF, and general drawbacks in using the technology. The journals in the internet were found from different WebPages such as Google, Ask and Yahoo that referred to links to websites of journals related to safe water drinking options.

The research methods in case of literature review were thus:

i. Reviewing secondary documents (Publications, web, newspaper, etc)
ii. Listing down and grouping all possible indicators in order to investigate the suitability of PSF in the aspect water quality, management and disaster resilience
iii. Developing questionnaire based on background information and conducting assessment of technology based on sustainability indicators

B. Collection of Primary Data

A field visit will be carried out to storm surge prone areas selecting post Aila affected areas as a case study in Shymnagar, Satkhira district to interview and discuss with target groups such as users of PSF to understand the functioning of the technology, its limitation and maintenance using sustainability indicators. Key informants from different governmental and non governmental institutions will be interviewed to compile their experience on the intervention of PSF in coastal areas to decide on the recommendations.

The research methods in case of primary sources will be:

i. Collecting and compiling expert's opinion about the possible indicators to investigate suitability of PSF in the aspect of water quality, management and disaster resilience
ii. Discussion with local and international NGOs & GOs about their experience on the intervention of PSF and suggestions on its suitability as safe drinking water option
iii. Conducting field visit to a Aila affected regions in the coastal area
    a. Interviewing/ Discussion with local community/ users of the system

b. Discussion with Elites, local NGOs & GOs about the intervention, maintenance and limitation of pond sand filter and suggestions for using the technology as safe drinking water option.

Reference to Research Design:

As reference to the research design, two research paper on ‘Solution Exchange for the Climate and Disaster Risk Reduction Community Consolidated Reply Query: Safe Water for the South West – Experiences; Advice Compiled by Dilruba Haider, Community Facilitator and Shibaab Rahman’ and ‘SWOT Analysis and Sustainability Study for A Service Sector-A Case Study of TWAD Board, TWAD Board’ had been used.

3.2 Research Strategy:

The study was mostly qualitative, based mostly on the field findings and literature review. Due to time constraint only five PSF could be studied on the basis of sustainability indicators as qualitative assessment was made. Quantitative analysis could be considered in case of further study of PSFs with larger sample size.

3.3 Study Area

Coastal Area of Bangladesh (Shymnagar Upazila, Satkhira district of the Khulna Division)

3.4 Sampling Area

a. Upazila

Out of 7 upazilas in Satkhira district, Shymnagar was most severely affected in which 243293 were affected out of 569810 total affected mass (In-depth Recovery Needs Assessment of Cyclone Aila Affected Areas, 25-31 October 2009, conducted by International agencies (ActionAid, Concern WorldWide, DanChurchAid, MuslimAid, Islamic Relief, Oxfam-GB and Save the Children-UK) currently involved in Aila response programme funded by ECHO).

b. Union

In Shymnagar upazila, Gabura & Padmapukur unions were greatly impacted of which Gabura was most devastated (where total population affected was 30034) (In-depth Recovery Needs Assessment of Cyclone Aila Affected Areas, 25-31 October 2009, conducted by

International agencies (ActionAid, Concern WorldWide, DanChurchAid, MuslimAid, Islamic Relief, Oxfam-GB and Save the Children-UK) currently involved in Aila response programme funded by ECHO)

Therefore the sample area considered is union of Gabura of Shymnagar upazila. However, due time constraint and weather conditions, Munshiganj union are selected as the sample area where five (5) PSF is studied, all of which community based.

3.5 Target location

Target locations are chosen depending on the suitability of the research:

a. **PSFs (5 household-based/community-based):** In order to investigate the functioning of the PSFs, it is necessary to physically visit and observe the site where PSFs are located.

b. **Community homes adjacent/distant to PSFs/users of PSF:** In order to investigate usage of PSF water by the users, it is important to interview its users in community homes either adjacent or distant to PSFs. In addition, how the PSF water is utilized and consumed can also be observed through visits in community homes.

c. **NGO Beneficiary Group/GO Offices:** In order to understand how NGOs and GOs are providing PSFs to the communities and their experience i.e. difficulties and success in installing PSFs, respective NGO and GO officials will be interviewed through KII.

d. Community bazaars/markets: A physical observation in community bazaars and markets will be necessary to understand if there are skilled labors and spare parts of PSF available in the area that will ultimately determine the degree of acceptability and use of PSF in the area.

3.6 Target Groups

The target groups selected for the study were community people/users of PSF (mainly women and young girls), elites (such as member or chairman) and NGO/GO officials.

3.7 Tools & Technique

As already mentioned, the techniques employed to conduct the study were reviewing secondary documents and conducting field visit. In the field, the tools that were used in the study were informal interview, key informant interview and physical observation.

3.8 Sustainability Indicators

Several sustainability indicators were considered in the context of research location. Some of which were:

i. Are communities using the system?

ii. Are communities repairing the system?

iii. Can communities afford to bear operation and maintenance cost?

iv. Are communities getting safe and adequate drinking water?

v. Are same or other communities replicating the technology?

vi. Is the technology functioning well?

vii. Is the technology estimated to run long without major repairing?

viii. Are spare parts of the system locally available?

ix. Are skilled labors available within the community for repair/replace?

The indicators are grouped under three important aspects: water quality, management and disaster resilience:

A. Drinking Water Quality

Water quality is analyzed through its chemical, physical and biological content. Chemical content is analyzed through assessing its hardness (calcium + magnesium), contents of metals (iron etc), nutrients (nitrogen and phosphorus), chloride, sodium, organic compounds, etc. Physical content is assessed by turbidity, color and odor and biological content is studied on its fecal coliform and viruses.

B. Management of the Technology

1. <u>Social Aspect</u>

The social aspects are studied based upon the communities' affordability in bearing the cost for maintenance and repair, location of the PSF, water quality and amount of water received for drinking and its replication in other areas. Tools are accordingly used in order to understand the overall social aspects which are briefly discussed in the following.

a. **Are communities using the system and can they afford to bear operation and maintenance cost?** (through observation of PSF system and group discussion of users such as young girls and women)

b. **Are communities getting safe, adequate and quality water?** (through group discussion/ interviews of users/households on quantity of water, its daily use and health problems and observation of local people drinking such water)

c. **Where is the PSF located?** (Availability of ponds/ distant from users through physical observation)

d. **What is the size of PSF?** (Considering the capacity of reservoir through interview locals and care taker)

e. **Are same or other communities replicating the technology?** (through KII of stakeholders such as DPHE and interview of local communities)

2. <u>Technological Aspect</u>

The technological aspect is studied through its status of functioning, longevity and operation and maintenance. The technological aspects and the tools utilized for assessment are briefly discussed below.

a. Is the technology is well functioning?

The technological functioning is analyzed through its quantity and quality of drinking water, functional filter bed and parts and efficient drainage system some which are briefly discussed below.

i. Does it produce adequate quantity of water and have acceptable quality round the year?

ii. Are all necessary parts are in place?

iii. Is filter bed functional?

iv. Is good, clean and effective platform available?

v. Is effective waste water disposal pit or drainage system available?

(Through observation of PSF and interviewing users of local communities and care takers)

b. **Is the technology estimated to run long without major repairing?** (through interviewing local communities to learn the status of such technology that are 4-5 years old)

c. **Is the technology well operated or maintained?** (through observation and informal interview of users)

3. <u>Hydro-geological Aspect</u>

a. Is water available round the year? (through interview of locals)

4. <u>Economical Aspect</u>

The economical aspect is assessed through skills of labor, installation cost and availability of spare parts.

a. **Is skilled labor** available within the community for repair/replace? (through interviewing technicians to learn about repairing of PSF parts and their availability)

b. What is the minimum installation cost? (through interview with care taker and NGOs)

c. Are spare parts available in the local market? (through interview of locals)

5. <u>Environmental Aspect</u>

Environmental aspect is studied through unwanted material generation and possible susceptibility of bacteriological contamination.

a. Are unwanted material generated from PSF?

b. Is there susceptibility of bacteriological contamination?

(Through interview of locals, care takers and physical observation)

C. **Disaster Resilience**

Resilience towards disaster is analyzed through PSF's capacity to withstand impacts from storm surge, continual and effective functioning during normal time and post disaster.

a. **What is the capacity of PSF to withstand impacts of storm surge?** (through interview of locals and care takers)
b. **What is its capacity to continue functioning during disastrous events?** (through interview of locals and physical observation)
c. **What is the capacity to function during post disaster?** (through interview of locals and physical observation)

3.9 Data Analysis

Analysis of data is carried out through field survey of community people using PSF and compilation of experience through various institutions which have had PSF in Aila affected areas of Shymnagar, Shatkhira district. The limitations of the technology are assessed through interview and group discussion of target groups using the selected indicators. Since this is greatly a qualitative research, the result of the study cannot be directly interpreted in forms of graphs or figures. Tabular representation on the water quality of PSF was produced against certain sustainability indicators to represent the sustainability and acceptability of the system by users in the area.

3.10 Quality Consideration

In terms quality consideration, a number of factors were looked into in order to maintain the quality of the study. The sample size of interviewee in all selected locations was maintained. Women & adolescents (users) chosen for interview in the field were of similar age range. Research methods and interview questions were prepared using the paper reviewed. Finally, the author had personally carried out the study in the field.

CHAPTER 4: INVESTIGATING SUSTAINABILITY OF PSF: A CASE STUDY OF POST-AILA SITUATION IN SHYAMNAGAR, SATKHIRA DISTRICT

4.1 Suitability of Pond Sand Filter: Assessment and Analysis

Due to time constraint and weather conditions, the study was conducted in Munshiganj union of Shyamnagar upazila instead of Gabura union. Munshiganj was also affected during Aila. With an area of 49 sq km and a total of 18 villages, it has a total population of 30,213 and 6227 families. The various water interventions over time in this region were PSF, shallow and deep tube-wells and rain water harvesting system. The total coverage of PSF in the region is 75 while the coverage of tube-wells is 235 and rain water system is 164.

A. Drinking Water Quality

Due to time constraints the biological content and chemical content of the water could not be tested. The physical content of the water from 5 PSFs are summarized below:

Table 1: Summary of physical content of PSF water form five locations

PSF	Village	Operational Status	Turbidity of water	Color	Odor	Comments
PSF 1	Kodomtola	Operational	Less turbid (less than 5 NTU)	Clear	No	The quality of water was well accepted by communities as 2500 beneficiary family collects water from the PSF everyday for drinking purpose.
PSF 2	Munshiganj	Operational	Less turbid (less than 5 NTU)	Clear	No	The quality of water is accepted by communities but certain levels of bacterial contamination were suspected since the ceiling of PSF, which was constructed out of iron sheets, was broken. Thus bird droppings and dirt could pollute the water.
PSF 3	Munshiganj	Out of order	Very turbid (More than 5 NTU)	Straw	Yes	The PSF was functional before Aila. However, since

						inundation of the pond, and despite dewatering afterwards, salinity could not be removed and the PSF is left bare.
PSF 4	Munshiganj	Out of order	Very turbid (More than 5 NTU)	Straw	Yes	The PSF was functional before Aila. However, since inundation of the pond, and despite dewatering afterwards, salinity could not be removed and the PSF is left bare.
PSF 5	Dhankhali	Out of order	Very turbid (More than 5 NTU)	Straw	Yes	The PSF was functional before Aila. However, since inundation of the pond, and despite dewatering afterwards, salinity could not be removed and the PSF is left bare.

B. Management of the technology

Social Aspect: Number of PSF; Operative; number of users; location

Despite availability of PSF in the target villages of Kodomtola, Munshiganj and Dhankhali, only a few are currently operative. The total number of PSF in Kodomtola is 4 of which 2 are out of order. While the 3rd PSF is operative, the water from it is saline and is not drinkable. Thus only one PSF in the village is being used by the lion fraction of the village population. Although as many as 5 PSFs were available in the village of Munshiganj, only one was operative. The PSF was not centrally located as people from as far as 2 km away would come to collect water everyday (see fig 8). In Dhankhali, out of the four PSFs available, none of them were operative. People in the village currently depended on pond water while others may bring water from distant PSFs in the adjacent villages. Of the four PSFs which were out of order, one, which had been located near a homestead, was studied. Two more PSFs were observed in Munshiganj which were totally out of order. They were constructed before Aila by Solidarities. During Aila the ponds were flooded with saline water and despite pond dewatering, the salinity of the ponds could not be removed. As a result the PSF remain out of order and no follow-ups had been taken while the pond is used for household activities.

Clearly the intervention by both government and NGOs on installation of PSFs has been wide and vast since long in this south-western region. The PSF in Kodomtola had been constructed by LEADERS, a local NGO, ten years back while the PSF in Munshiganj had been constructed by the government 12 years ago and the PSF in Dhabkhali had been intervened by Shushilan 5 years before. As a result, the practice of drinking water from PSF by the locals has been for long.

Through interviews among community people, it was learned that far before the intervention of PSF, people used to drink tube-well or pond water. However, as water table began to fall and intrusion of saline water rose, deep tube-wells in the region were becoming unsuccessful and the only source of fresh drinking water then were the ponds. Later, with the intervention of PSF, the use of PSF water for drinking purpose spread.

A large number of beneficiaries depend on the PSFs as drinking water sources. As many as 2500 gather at the PSF in Kodomtola to collect water everyday since early morning to late evening. In Munshiganj, around 1500 beneficiaries both from closing and far distant come to collect water from the PSF there and while there has been no operative PSF in the village of Dhakhali, people drink water from distant PSFs while others use pond water for drinking purpose.

Maintenance & Technical difficulty

The degree of maintenance of each PSF varied from one location to the other. While in Kodomtola the pond adjacent to the PSF was relatively raised, large and clean, the pond at Munshiganj was low and turbid. In Dhankhali, where the PSF was out of order, the pond adjacent to it was almost bare, containing little water that was turbid and saline.

When it came to maintenance, it seemed it was mostly upon the caretakers who owned the ponds. As in the case of the PSF in Kodomtola, 3 families (15 members) were in charge of maintenance of the PSF who were also the owners of the pond. The caretakers were trained by LEADERS NGO during construction of the PSF. According to them, the pond was kept out of any household activities, domestic livestock or fish cultivation. Calcium carbonate was added at regular intervals for purification of water and the pond was kept clear of any floating materials. The PSF was also well constructed with cemented walls and roves. A tube-well was used to pump pond water into the filter and two taps were connected to the outlet. The size of the PSF was around 90 cft providing more than 15,000 liters of water everyday. The situation, however, was different from that in Munshiganj where, as learned from the communities and care taker, no training on use of PSF or its technical knowledge was given to communities. The care taker for the PSF had been maintaining the PSF through learning from other PSF users. In addition, there had been no follow ups from the government since its intervention. As in Kodomtola, the pond was not used for any domestic or other household activities and calcium carbonate was spread into the pond for purification of water. The structure of PSF was partly damaged. The lid of the PSF was made from corrugated iron, part of which was broken, and tube-well was out of order. Thus people had to pour water directly from the pond to the filter. In addition, the pond banks were low. However, the sand in the filter bed was cleaned at one month interval. The size of the PSF was 70 cft, smaller than the one at Kodomtola, with damaged taps and pipes connecting the PSF.

In Dhankhali, during Aila, the PSF was out of order since the pond was inundated with saline water (see fig 9). Dewatering was later carried out by Solidarities. However, the salinity of the pond could not be removed. As a result despite repairing of the PSF, it could not be operated. The people from Dhankhali collects water from half km away and mostly depend on pond water. The size of the PSF was 70 cft and around 250 households used to benefit. The quality of water was relatively good. 5 people were in charge of its maintenance who were trained by Shushilan. There were constant follow ups before Aila. The community people used to notify Shushilan for any assistance and they were accessible. All community members used to contribute for small technical difficulties and for larger ones, Shushilan used to assist.

According to the caretakers in Kodomtola, the most common technical difficulties were taps and its connecting pipes going out of order. Repairing of these takes place through contribution from the locals each beneficiary families contributing 2-5tk. The average repairing cost per month is about 200-250 TK. Such difficulties are encountered once or twice a month. Similar contribution was made whenever cleaning of the filter bed was necessary. The care takers reported, in total, ten people were required to clean the filter materials in the PSF. The filter bed was cleaned after every three months interval although it should have been cleaned after each month. An average of 600-700 TK would be spent on cleaning of the PSF filter. Water from the PSF is stored in a reservoir from which the water is provided to the beneficiaries until the cleaning is completed. In rare cases, tube-wells may not function. In such and other large technical difficulties the caretakers would notify LEADERS, the local NGO that constructed the PSF, who would support financially for necessary repairing. Unlike Kodomtola, locals in Munshiganj would make little contribution in case of small technical difficulties and it was the care taker who would often make most of the expenditures to keep the PSF functioning. In addition, government barely made any follow up since intervention.

In Kodomtola, water testing was generally carried out at three months interval and during intervention. The care takers were available at most times and assistance could be received whenever required. The repairing materials were also found in the market place close by. Training of communities regarding use and technical know how on PSF was only carried out during intervention. However, the use of PSF has spread over time as new users have become motivated and learned the technical use from previous users. As discussed, unlike in Kodomtola, in case of small technical difficulties in Munshiganj, the care taker usually bore most of the expenses since others would contribute very little. In case of cleaning the filter bed, the expense was shared among the communities. Unlike in Kodomtola, the filter bed was cleaned by 7 women costing 600-700 tk in every 1.5 months interval. Water testing was only carried out twice since intervention. There was no other intervention of PSF in the region. However, in contrast to the PSF in Kodomtola, the PSF in Munshiganj had a proper drainage system. The waste water and sand from the platform is drained to a drainage system kept away from the pond or PSF , thus there is less chance of contamination.

Women in all locations would generally pump the tube-well water into the PSF. However, in case if the tube-well head is out of order, they pour water directly from the pond into the filter. In Kodomtola, in case the sand in the PSF is renewed, it is dumped at a corner which however is at closing distant from pond and there are chances of biological contamination. On the other hand, the water and sand from the platform is drained out back to the pond again which increases chance of contamination. The platform was also noted to be muddy and unclean due to the increased use of PSF water by thousands of beneficiaries a day. However, in Munshiganj, a proper drainage system was noted where the waster water and sand from the platform was drained into a drainage system away from the pond or PSF thus preventing contamination.

Usually as noted from the field in all location, it was women of all ages, and particularly young married girls, who came to collect water from PSF. They carried water in pitchers and containers three times a day. Many young girls, particularly those coming from distant,

Figure 8 A functional PSF in the village of Munshiganj; In the upper left corner-A woman collecting water; At the upper right corner-the roof of the PSF is partially damaged and is barely covered with corrugated iron sheets; At the lower left corner-one of the taps of the PSF is out of order; In the lower right corner- the tube-well is out of order while the banks of the ponds are not raised (bottom)

Figure 9 A non-functional PSF in Dhankhali and abondoned pond below which had been inundated with saline water during Aila

complained that they encountered taunts on their way when bringing water. To cope with the situation, the girls usually come in groups in order to ensure security and safety on the roads.

Two more PSFs were observed in Munshiganj which were totally out of order. They were constructed before Aila by Solidarities. During Aila the ponds were flooded with saline water and despite pond dewatering, the salinity of the ponds could not be removed. As a result the PSF remain out of order and no follow-ups had been taken while the pond is used for household activities.

Hydrological aspect

Although water was available year round, the demand for water was highest during the summer when the pond water dried and there was less availability of water in the PSFs. The four months of summer were crucial as admitted by one of female users named Halima, “We have to make long ques which sometimes leads to wrangles”. Many said that they started collecting water right after sunrise. With less availability of water during summer, people use PSF water only for drinking while cooking is usually done with pond water. Thus the use of water is reduced then. The people in this region do not prefer rain water for drinking or cooking purpose. While some in very distant locations may collect it for drinking, other may use it for bathing only. The situation was similar for the village of Munshiganj.

C. <u>Disaster resilience</u>

During Aila, the locals in Kodotola produced a raised embankment near the river banks so that water from the river could not flood the pond. Thus they were able to continue using PSF even after the disaster. However, the embankment later was dismantled and so now there was no permanent disaster resilient structure that could protect the PSF and the pond together.

Before Aila, the PSF in Munshiganj was operative. However, according to the locals, the water from the PSF would smell and was not drinkable right after intervention. During Aila, the pond was inundated as it became saline through intrusion by the flood water. The PSF was unusable for at least a month. Later the pond was dewatered twice by the government and during monsoon rainwater filled the pond and PSF became operative once again. The quality of water was far better than before. During the disaster situation, the locals depended on the pond water for drinking or cooking purpose while other received water from water trucking. The ponds were also lower and there had been no resilient structure that could prevent the ponds from inundation.

As already mentioned, in Dhankhali, during Aila, the PSF was out of order since the pond was inundated with saline water. Dewatering was later carried out by Solidarities. However, the salinity of the pond could not be removed. As a result despite repairing of the PSF, it could not be operated. The people from Dhankhali collects water from half km away and mostly depend on pond water. In Dhankhali, the locals were in desperate search of finding drinking water sources nearby within their village since all PSFs in their region is out of order and they have to walk long distance to collect water. They suggested that in order to make PSF disaster resilient, both PSF and the banks of the pond has to be raised so that it is not inundated in flood water. They admitted there was another pond nearby which was raised and could be piped to PSF that was out of order for use. However, the expense for this was too much to bear and they would require 10,000 tk in total. In spite of informing the matter to the NGO or government officials, no initiative as of yet has been taken.

D. Limitations and Prospects

In all locations, the locals admitted that the limitation of PSF's suitability is the lack of fresh water ponds since most ponds are either saline or is being used by communities for domestic purpose. Through interview of community people, it was learned that they required more PSFs in the area but lack of fresh water ponds and its proper maintenance stands out as the major obstacle in the suitability of PSF. According to them, some new intervention on PSF had been carried out after Aila but due to lack of fresh water ponds, they are now out of order.

The concept of community based disaster fund was not known to any. According to the community, such an approach will not work unless the mindset of the people is changed and there is trust and respect towards each other. They suggested that if the concept was introduced through a reliable representative such as an NGO or government and communities were motivated, community based disaster fund could work and people could become self-reliant.

According to the locals, banks of the ponds should be raised either with mud or cement above the highest flood water level (4ft) so that saline intrusion particularly during flood is prevented. Since Aila, many ponds have become saline which despite dewatering, salinity from ponds could not be removed. Although during Aila, community people in Kodomtola village did produce a temporary embankment near the river to prevent pond from inundating, there has been no permanent initiative from the government, NGOs or locals to protect the pond had another disaster stroke again. They also suggested that the PSF could be made larger with more capacity and four taps, so people did not have to wait in long ques. They also suggested that in order to better cleanse the filter bed, finer sand particles could be used to remove bacteria and better purify water.

Bridging the Gaps

Through literature review and field tour, the major limitation of this technology is raw water storage. The pond must be large enough to ensure that it will not dry out in the dry season. In addition, the banks of the ponds have to be raised well above the ground at least above the previous flood water level so that it is not inundated during disasters. It is also important to ensure that the salinity and iron content of the pond water not exceed 600 ppm and 5 ppm, respectively, at any time of the year.

The communities should be provided training or workshops on the use and technical know how on PSF. The caretakers should be provided with adequate training on the maintenance of the PSF and cleaning of filter beds. The concept of disaster fund could be introduced through NGOs or government officials who through motivation could make communities self-reliant and build capacity to cope with technical difficulties of PSF and to make it disaster resilient through collective decision making and contribution. The NGOs and government officials, those constructing PSF, should keep up the follow up so communities are able to address the difficulties they encounter.

4.2 Institutional Arrangement & Community Organizations for PSF Distribution & Maintenance

4.2.1 GOs: Implementation of PSF

Through interview of members of the targeted villages, it was learned that despite availability of PSF, most are out of order since Aila hit. The ponds had been inundated with saline water which even after several attempts of dewatering, salinity in the ponds could not be removed. The member at the village of Munshiganj reported that there were a total of 30 PSF of which only 5-7 PSF were actually functioning. NGOs such as Solidarity, Gonomukhi Foundation and Shushilan and government organization like Janoshastho worked and are still working in the villages.

According to the member in Munshiganj, tube-well intervention was unsuccessful since the disaster. The PSF interventions are still ongoing in the area. Government, itself, is providing PSF on household basis in exchange of 3000 tk per family. The PSFs are constructed regardless of any assessment on suitability of PSF. Most of the ponds in the region are saline affected and as a result the PSFs are non-functional.

The member agreed that community based disaster fund could be successful had it been introduced through a reliable representative such as government or NGO officials. Motivation and awareness should be created among communities so that they could realize their ownerships of PSFs. According to their opinion, further intervention of PSF would address the drinking water crisis in the region since most ponds are saline affected. Thus one of the major initiatives is to make ponds resilient to flood and raise the banks above the highest flood water level (5ft). The members of the villages suggested that solar PSF could function better than regular PSFs which could benefit 5000 families at a time.

The member at Munshiganj suggested that since almost all ponds in the village were saline affected, a new artificial lake or pond could be constructed with a larger PSF which could provide water to the whole of the village for drinking purpose while other ponds could be used for household activities. According to the members, solar deep tube-well has been installed as piloting project and is currently successful in areas like Kultol, Moltob and Shingortoli. The tube-well is operated by solar panels with motors pumping ground water and distributing water through pipes to three villages of Kultol, Moltob and Shingortoli which are 1 km, 3km and 1.5km distant away from the centrally located water technology. Having said that the technology may not be suitable where fresh water aquifers are scarce as is the case in Munshiganj village, where despite several attempts for deep tube-well installation, it did not succeed due to lack of aquifers.

4.2.2 NGOs: Roles and Limitation

Through an interview with a Project Engineer from Banchte Shikha, a local NGO who previously worked as Public Health Engineer at Progoti, another local NGO in Satkhira, it was learned that PSFs are very well accepted among communities. An area where salinity levels are high and fresh water aquifers are hard to find, people greatly depends on pond water for drinking water sources. As a result, pond sand filters which treats pond water and other surface water is widely accepted by communities in the area.

He reported that during intervention of a PSF, a committee of 9-11 members are formed who are responsible for its maintenance. After intervention, NGO bears the total construction cost and may contribute in large technical difficulties. The use of PSF in the south western regions is extensive. PSF water causes less gastric problem unlike tube-well water which comprises of high iron content.

The common technical difficulties in operating PSF are replacing and cleaning of filter beds at regular intervals. Generally the filter bed should be cleaned at one month intervals. The removal of algal layer over the sand filter is important. In case the PSFs are not cleaned for 3 months, a thin layer of the filter bed should be removed so that there is no contamination of bacteria. The overhead tank should also be cleaned to remove turbidity of water and algae. Two labors and a care taker are generally trained by NGOs on technical know how of the PSF so that they can fix small technical difficulties, the expense which is often shared among communities. According to this NGO, follow ups are taken after the intervention and community based disaster fund for all technical difficulties is maintained. PSF requires ponds with fresh water and a regular PSF can serve a minimum of 200 beneficiary families. Generally such regular PSF last for 4-5 years with an average installation cost of 80,000 tk. The major limitation of PSF is that ponds with fresh water should be available where the salinity levels are low. No fertilizers for fish cultivation can be used. The pond banks should be raised to prevent saline water intrusion. The quality and quantity of sand materials in the filter bed should be well maintained and the cleaning should be carried out at regular intervals. Since the ponds are household based, it may become a challenge since it comes voluntarily among community members who would donate his pond for PSF installation and drinking water purpose and giving up other opportunities of cultivating fish and profiting from it. In many other areas, however, due to the immense scarcity of drinking water, many would simply offer their ponds for PSF construction.

Banchte Shikha is currently implementing a modified version of PSF in Dacope which is also called the ‘Solar PSF’ which unlike regular PSF are automated and the tanks are always reserved. The capacities of the PSFs are also larger with 4 taps at its outlet and can provide 10,000 litres of water per day.

Although the costs of installation of such PSFs are about 4 lacs, they last for 20-25 years. The PSF also has aeration mechanism which causes algae to feed more and grow as the filter beds do not let it through and reduces water turbidity. Safe disposal of used filter beds is required which otherwise could lead to contamination.

Another Project Engineer, who has worked at Progoti and is currently working at Shushilan since the past two months, said that Progoti had carried out a number of water interventions through PSF installation, pond dewatering and deep tube well installation. Progoti installed both small and larger sized PSF, one that provided water to 100 households and other that provided water to 200 households per day. An average PSF may provide 1500litrs of water per day. PSFs are generally community based. After Aila, many ponds had been dewatered for it to collect rain water. Before installation of PSF, communities were asked about what water intervention would benefit them. Sites were then assessed and selected accordingly. The PSFs that were provided by Progoti were funded through Oxfam. According to him, in most of these areas, tube wells are not successful due to unavailability of fresh water aquifers while on the other hand, people are accustomed in drinking pond water and prefer it more than rain water. Thus PSF is a suitable drinking water option for them. Currently in many areas, solar PSFs are being installed such as in Assashuni, Monirampur in Jessore and Dacope in Satkhira. However, due to lack of maintenance the PSFs in most areas are not operative. Thus people opt to drink pond water. There is also lesser degree of motivation and since after intervention of the PSFs, follow ups are not kept by all NGOs, PSFs do not become successful.

The solution to the problem, according to him, is that the users should be motivated and should understand his ownership to the PSF. There should also be community based fund rising so that they are able to address small technical problems. In addition, in terms of leadership, women may play a better role than men since it is them who are greatly involved in bringing and collecting water. The common technical problems of PSF are plasters coming off and pipes and tube-wells going out of order. This has become a far greater problem ever since Aila. Although PSF water may be available year round, scarcity is highest during the summer.

Through and interview with a Public Health Engineer at Oxfam, an international NGO, it was learned that Oxfam had several water intervention in the south-western region of the country. Such interventions included rain water harvesting both at household and community level, water trucking, solar operated PSF at Kamarkhola & Sutarkhali Unions under Dacope upazilla of Khulna and renovation of deep and shallow tube-wells and PSF under Koira of

Khulna and Shymnagar of Satkhira. Such areas were selected for water intervention since the areas suffer significantly from water crisis. Since Aila, Oxfam renovated some of the PSFs there: one at Shymnagar, Satkhira and four at koira, Khulna. The number of beneficiary families using the PSF is on average 50-75 per PSF and each HH can collect 30-50 litre of water daily. All PSF were community based and a water management committee is formed at the local level among which are management committees and care takers. They are provided necessary training to maintain the PSF. Training was also conducted for the management committee with the beneficiaries so that they are taught the technical know how of the PSF. The PSFs constructed were not completely disaster resilient. According to him, Brick work could be of more thickness (more than 5 in), the top cover could be well clamped so that due to high wind, it does not come out, other pipe fittings etc. Moreover, the PSFs could be constructed in high level of land so that it will not be inundated during any hazard and pond protection is also important. Oxfam in connection with DPHE has modified PSF design called solar PSF and accordingly, implemented (03) in Assasuni under Satkhira and 02 under Dacope of Khulna. Oxfam used solar energy to pump out water from pond to reservoir tank.

According to him, the communities would prefer deep tube-well water more than PSF. Due to lack of water aquifers and unsuccessful tube-well installation, people now depend on PSF. Ownership is the main social aspect for the sustainability concern. In many cases, the realization of ownership of communities is missing. Thus it is important to create ownership among communities and DPHE should take the of operation and maintenance of all PSFs. Follow up of the PSF constructed can not be kept once the project period ends, since budgeting of repair, renovate or follow up ends after intervention of PSF is complete. In order to enhance the PSF, the roof must be kept closed since there is a chance of the contamination by bird droppings. In addition, bio-sand filter could be created to remove bacteria.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

PSF provide a drinking water option in saline and storm surge prone areas as the south-western coastal regions of the country. According to the field findings, functioning of PSF depended very much on the maintenance of both the PSF and its adjacent pond. In this regard, communities' collective effort and contribution is vital which seemed to be lacking. As suggested by the locals in the field and NGO officials, PSF could be made disaster resilient through raising banks of the ponds as well as the technology itself.

Out of five PSF studied, only two in Kodomtola and Munshiganj village were functional while the rest were out of order since cyclone Aila in 2009 brought inundated ponds and PSF with saline flood water. In spite of desalination by NGOs after the disaster, the PSF could not be operated due to large scale of salinity in the ponds. Among the two PSFs in Kodomtola and Munshiganj village which are currently functional, the PSF roof in Munshiganj was partly broken and barely covered with corrugated iron. Hence certain level of bacterial contamination was suspected as bird droppings and dirt could pollute the water in the filter bed. Communities' level of participation and contribution in terms of repair and maintenance of PSF and its adjacent pond seemed to be lesser in Munshiganj in comparison to Kodomtola due to lack of awareness and 'feel' of ownership. Although there are no disaster resilient structures of PSF or its pond, during Aila, the communities in Kodomtala produced a temporary embankment with mud to prevent flood water inundating the pond. As a result, communities were able to seek drinking water even during the post disaster although the embankment was dismantled later. Finally, the concept of disaster contingency fund for maintenance and repair of the technology during and post disaster situation was new and alien to most locals. They felt that the concept could be introduced through a representative such as UP member or NGO. A few of the locals mentioned that the they should be made aware about the importance of their collective effort and contribution in maintaining PSF, hence will the PSF sustain for long and provide them safe drinking water. Same was emphasized by NGO officials, who confessed that follow ups can not always be kept, since funds are not available for necessary repair or maintenance after the installation of PSF is complete.

As a result of time constraint, only a few PSF could be studied. Thus no conclusion can be drawn on the suitability of PSF in the area and further study on more PSFs on different geographical context is required.

5.2 Recommendation for Further Study

Due to time constraint and weather condition, only five PSF could be studied. Thus in order to enrich the study, more PSFs in different geographical location could be assessed. The number of interviewee could be increased to attain an overall idea on the suitability of PSF as drinking water options. Comparison between regular PSFs and modified versions could be compared to understand its suitability. In addition, experience of other NGOs should be compiled to understand the sustainability of the system in the region.

Reference

- *Analysis and Sustainability Study for A Service Sector-A Case Study of TWAD Board.* TWAD Board.

- Bangladesh WASH, K. B. (09-10 December 2009). *Learning and Knowledge Sharing Workshop on Response to Cyclone Aila Khulna.* Water Aid.

- Board, T. *SWOT Analysis and Sustainability Study for A Service Sector-A Case Study of TWAD Board.* TWAD Board.

- Haider, D. (14 July 2011). *Solution Exchange for the Climate and Disaster Risk Reduction Community Consolidated ReplyQuery: Safe Water for the South West – Experiences.*

- Sharmin, F. (20 April 2010). *Sustainable Alternative Water Supply Technologies in Arsenic Prone Areas of Bangladesh.*

- Zaman, M. *Climate Change, Cross border Migration and Regional Conflicts: Risks and Strategies for Bangladesh; Bangladesh Calling for Climate Justice.*

- Retrieved January 8, 2012, from www.dmb.com

- Retrieved December 4, 2012, from http://pravdabangladesh.wordpress.com/access-to-safe-drinking-water/

- Retrieved December 4, 2012, from http://phys4.harvard.edu/~wilson/arsenic/conferences/Feroze_Ahmed/Sec_3.htm

- *Disaster Management Bureau*. (n.d.). Retrieved January 8, 2012, from www.dmb.com

- Hafizi, N. (2011 , March 1). *Unnecessary and Deadly: The Post-Disaster Catastrophe of Waterborne Diseases.* Retrieved January 5, 2012, from The Triple Helix Online: http://triplehelixblog.com/2011/03/unnecessary-and-deadly-the-post-disaster-catastrophe-of-waterborne-diseases/

- Haider, D. *Solution Exchange for the Climate and Disaster Risk Reduction Community Consolidated ReplyQuery: Safe Water for the South West – Experiences.* WaterAid.

- Sarwar, M. G. (2 1 N O V E M B E R 2005). *Impacts of Sea Level Rise on the Coastal Zone of Bangladesh.* Sweden: Lund University,.

- *World Environmental Library*. (n.d.). Retrieved January 11, 2012, from • http://www.greenstone.org/greenstone3/nzdl;jsessionid=FA59A7CADAEB74513D6E48B1A8959353?a=d&c=envl&d=HASH0189618d3b8bbcb233c8d080.4.4.3.pp&sib=1&p.s=ClassifierBrowse&p.sa=&p.a=b

- WorldWide, A. C., DanChurchAid, MuslimAid, Relief, I., Oxfam-GB, & Children-UK, S. t. (25-31 October 2009). *In-depth Recovery Needs Assessment of Cyclone Aila Affected Areas, , conducted by International agencies.* ECHO.

ANNEX

Questionnaire

Subject: Suitability of Pond Sand Filters as Safe Drinking Water Solution in Storm Surge Prone Areas of Bangladesh: A Case Study of Post-Aila Situation in Shymnagar, Satkhira District, Khulna

The following is a questionnaire for users (women) of Pond Sand filters (PSF) (aged 22-40) to learn about suitability and effectiveness of PSF to the respondent in terms of its water quality, management and resilience towards disaster. This survey is being conducted by Sayeeda Farhana, student of DMG 699 (Dissertation) class of Post-Graduate Program in Disaster Management at BRAC University. There are both open and closed ended questions. Women from various families regardless of class or religion can be interviewed in order to understand their ease and difficulties of using PSF.

Name……………………………………………………………………………………

Age ……….........

Sex ………………

Village …………………………………………………………………………………

Union ………………………………………………………………………………….

Upazila ………………………………………………………………………………..

District ………………………………………………………………………………….

A. Personal Background

1. Where are you living?

…………………………………………………………………………………………
…………………………………………………………………………………………

2. How long are you living here & with whom?

…………………………………………………………………………………………
…………………………………………………………………………………………

3. How many family members do you have & who are they?

…………………………………………………………………………………………
…………………………………………………………………………………………

4. Did you & your family live in the same residence before Aila?

- Yes

- No

If no, where did you live before and why did you migrate here?

……………………………………………………………………………………………………
……………………………………………………………………………………………………

B. Before Disaster (Normal Time)

Intervention of Water Technologies

1. What water options were here before Aila?
    - Pond Water
    - PSF
    - Deep/shallow hand tube-wells
    - Rain water harvesting
    - Others ……………………………………………………………………………………..

2. If there were PSFs in the region, which organization (governmental/ non governmental) were involved in intervention of these technologies?

……………………………………………………………………………………………………
……………………………………………………………………………………………………

3. How many of such PSFs were installed in your village?

……………………………………………………………………………………………………

4. How were the PSFs managed and who were responsible for its management?

……………………………………………………………………………………………………
……………………………………………………………………………………………………

5. How was the quality of water from PSFs then?
    - Good (Clear, odor free and does not taste saline)
    - Poor (Not so clear, odor and taste saline)

6. Did you use PSF water for drinking then?
    - Yes

    If yes, were you satisfied with the quality of drinking water, explain?

……………………………………………………………………………………………………
……………………………………………………………………………………………………

- No

If no, why?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

C. During Disaster

1. Do you think the PSFs were effective during Aila?

   - Yes
   - No

If no, what happened to the PSFs during the disaster?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

D. Immediately after Disaster

1. Were the PSFs that were damaged during Aila, repaired later?

   - Yes
   - No

If yes, by who?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

E. Post Disaster

Collection of water by users

1) Do you now collect safe drinking water from PSF for your family?

   - Yes

If yes, why did you select this water option?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

   - No

If no, why? (No need to proceed further)

…………………………………………………………………………………………………

…………………………………………………………………………………………………

2) Is this PSF household/community based?
   - Household
   - Community based

3) Who in your family is often responsible for collection of water?

………

4) How far is the PSF from your home and how long does it take to collect it?

………………………………………………………………………………………………

………………………………………………………………………………………………

5) How many pitchers/buckets of water do you collect everyday?

………………………………………………………………………………………………
………………………………………………………………………………………………

6) Do you encounter any social difficulties when collecting water from PSF?

- Yes

If yes, what and how do you cope with it?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

- No

Water Quality

7. How is the quality of water from PSFs now?
    - Good (Clear, odor free and does not taste saline)
    - Poor (Not so clear, odor and taste saline)
8. Has the quality of water remained that way since intervention?
    - Yes
    - No

    If no, how has it changed and why do you think it has?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

9. Has there been any water quality testing over time?
    - Yes
    - No
10. Do you feel comfortable drinking PSF water now?
    - Yes
    - No

If no, why?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

Why do you still drink this water?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

11. Do you receive water from PSF year round?

- Yes
- No

If not why and when?

………………………………………………………………………………………………………

………………………………………………………………………………………………………

Management (Operation, Maintenance and Technical difficulties)

1. To your knowledge, had there been any minor/major technical difficulties in the PSFs since its intervention?

- No
- Yes

If yes, what were they and when did it happen?

………………………………………………………………………………………………………

………………………………………………………………………………………………………

Had they been repaired afterwards?

- Yes
- No

If yes, who did the repairing?

………………………………………………………………………………………………………

………………………………………………………………………………………………………

2. How long has the PSF been running since intervention?

………………………………………………………………………………………………………

3. Who is generally now responsible for operation and maintenance?

………………………………………………………………………………………………………

4. Had there been any training/awareness program of communities for using PSF during or after intervention?

- Yes
- No

5. Had there been any follow up after intervention from the organization?

- Yes
- No

6. Are the intervention of PSF ongoing else where in your village?

- Yes

If yes, where and by who?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

- No
- I don't know

F. Suggestions and Way forward

1. Were the PSFs constructed after Aila disaster-resilient?

   - Yes

If yes, why do you think so?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

   - No

2. If no, how do you think they could be made so?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

3. To your knowledge, had there been any modification of PSF so far?

   - Yes

If yes what and how is it better than regular PSF?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

   - No

4. Should there be more intervention of PSF in the region?

   - Yes

   If yes, why and where do you think they should be located?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

   - No

5. What, in terms of water quality and management, should be done to enhance effectiveness of PSF in your area?

   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
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Key Informant Interview

Subject: Suitability of Pond Sand Filters as Safe Drinking Water Solution in Storm Surge Prone Areas of Bangladesh: A Case Study of Post-Aila Situation in Shymnagar, Satkhira District, Khulna

The following is a key informant interview for local NGO/GO and international NGO/GOs to learn about their experience and suitability of PSF in terms of its water quality, management and resilience towards disaster. This interview is being conducted by Sayeeda Farhana, student of DMG 699 (Dissertation) class of Post-Graduate Program in Disaster Management at BRAC University. There are both open and closed ended questions. The interview will carried out in order to understand the respondent's ease and difficulties of intervening PSF.

Name…………………………………………………………………………………………

Age …………..........

Sex ………………

Designation ……………………………………………………………………………….

Organization……………………………………………………………………………..

A. Intervention of Water Technologies (Coverage, Water Quality, Management and Disaster Resilience)

1. Did your organization have any water intervention before Aila?

- Yes
- No

If yes, what sort of intervention did it have and where?

- PSF
- Deep/shallow hand tube-wells
- Rain water Harvesting
- Others ……………………………………………………………………………………………..

2. Why were these areas selected for such interventions?

……………………………………………………………………………………………………
……………………………………………………………………………………………………

Reason for Intervention and Coverage

1. Did you have any intervention of PSF before Aila in Shyamnagar, Satkhira?

    - Yes

If yes, what was the coverage of PSF in the area (where & how many, average number of beneficiaries for each PSF & amount of water distributed from it)

……………………………………………………………………………………………………
……………………………………………………………………………………………………

- No (No need to proceed further)

2. Why did you think PSF could work as a safe drinking water option in such storm surge prone and saline affected areas?

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……………………………………………………………………………………………………

B. Types of PSF and its distribution to communities

3. Are the PSFs household/community based?

……………………………………………………………………………………………………
……………………………………………………………………………………………………

4. How are PSFs distributed among communities and how is it maintained?

……………………………………………………………………………………………………
…………………………………………………………………………………………………..

5. How much is invested for a PSF installation and what is the maintenance cost per month?

……………………………………………………………………………………………………
……………………………………………………………………………………………………

6. Who bears this repair and maintenance cost?

……………………………………………………………………………………………………
…………………………………………………………………………………………………..

7. Had there been any training/awareness program of communities for using PSF during or after intervention?

    - Yes

Who were trained and on what?

……………………………………………………………………………………………………
………………………………………………………………………………………………….

- No

8. Had there been any follow up after intervention?

    - Yes

- No

C. Disaster Resilience

9. Were the PSFs constructed after Aila disaster-resilient?

- Yes
- No

If no, how do you think they could be made so?
…………………………………………………………………………………………………
……………………………………………………………………………………………….

10. Are the intervention ongoing else where?

- Yes
- No

If yes, where?

……
……………………………………………………………………………………………………….

11. Has there been any modification of PSF so far?

- Yes
- No

If yes what and how is it better than regular PSF?
…………………………………………………………………………………………………
…………………………………………………………………………………………………

D. Management (Social and technical Aspects) and Water Quality

12. Do you think communities are well adapted to the PSF?

- Yes
- No

If yes, why?

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………………………………………………………………………………………………………..

13. Do you think the locals are adequately motivated to continue operating and maintaining the PSF and bear necessary repairing cost?

- Yes
- No

If no, how do you this could be done?

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………………………………………………………………………………………………………..

14. What social aspect limits its suitability of PSF in the region?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

15. What can be done regarding this?

    …………………………………………………………………………………………………
    …………………………………………………………………………………………………..

16. Had there been any minor/major technical difficulties in the PSFs since its intervention in Shymnagar after Aila?

    - Yes
    - No

If yes, what were they?
…………………………………………………………………………………………………
…………………………………………………………………………………………………

17. Do you address or assist in any technical difficulties after intervention?

    - Yes
    - No

    If no, why?

…………………………………………………………………………………………………
…………………………………………………………………………………………………..

18. How long does a PSF generally last?

    …………………………………………………………………………………………………..

19. Is water available through it year round?

    - Yes
    - No

If no, why not and when?
…………………………………………………………………………………………………..

20. Do you think the quality of water is better than that provided through other technologies? If yes, why?

…………………………………………………………………………………………………
………………………………………………………………………………………………….

21. Has the quality of water in any PSFs decreased since intervention and there been regular water testing after intervention?

    - No
    - Yes

    If yes, why?
    …………………………………………………………………………………………………
    …………………………………………………………………………………………………..
    If so, has anything been done regarding this?

…………………………………………………………………………………………………
……………………………………………………………………………………………..

22. Has the market system taken into consideration during its intervention?
    - Yes
    - No
23. Does PSF produce any unwanted discharge?
    - Yes

If yes, how is it removed?
……
……

- No

24. Is there any possibility of bacteriological contamination of water?
    - Yes
    - No

If yes, how and how can it be prevented?
……
……

E. Suggestions and Way Forward

1. How successful and suitable do you think are the PSF intervention?

……………………………………………………………………………………………………
…………………………………………………………………………………………………….

2. What major limitations are there that reduced its sustainability?

……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

3. What are your suggestions for overcoming them?

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……………………………………………………………………………………………………
……………………………………………………………………………………………………
…………………………………………………………………………………………………….

4. What, in terms of water quality and management should be done to enhance effectiveness of PSF in the area?

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……………………………………………………………………………………………………
……………………………………………………………………………………………………
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Key Informant Interview

Subject: Suitability of Pond Sand Filters as Safe Drinking Water Solution in Storm Surge Prone Areas of Bangladesh: A Case Study of Post-Aila Situation in Shymnagar, Satkhira District, Khulna

The following is a key informant interview for committee members and care takers of Pond Sand filters (PSF) to learn about suitability of PSF to the respondent in terms of its water quality, management and resilience towards disaster. This survey is being conducted by Sayeeda Farhana, student of DMG 699 (Dissertation) class of Post-Graduate Program in Disaster Management at BRAC University. There are both open and closed ended questions. The interview will carried out in order to understand the respondent's ease and difficulties of using PSF.

Name……………………………………………………………………………………

Age ……….........

Sex ………………

Profession ……………………………………………………………………………….

Village ……………………………………………………………………………………

Union …………………………………………………………………………………….

Upazila …………………………………………………………………………………..

District …………………………………………………………………………………….

G. Before Disaster (Normal Time)

Intervention of Water Technologies

12. What water options were here before Aila?

- Pond Water
- PSF
- Deep/shallow hand tube-wells
- Rain water harvesting
- Others ………………………………………………………………………………………..

13. If there were PSFs in the region, which organization (governmental/ non governmental) were involved in intervention of these technologies?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

14. How many of such PSFs were installed in your village?

…………………………………………………………………………………………………

15. How were the PSFs managed and who were responsible for its management?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

16. How was the quality of water from PSFs then?

- Good (Clear, odor free and does not taste saline)
- Poor (Not so clear, odor and taste saline)

H. During Disaster

2. Do you think the PSFs were effective during Aila?

- Yes
- No

If no, what happened to the PSFs during the disaster?
…………………………………………………………………………………………………
…………………………………………………………………………………………………

I. Immediately after Disaster

2. Were the PSFs that were damaged during Aila, repaired later?

- Yes
- No

If yes, by who?
…………………………………………………………………………………………………
…………………………………………………………………………………………………

J. Post Disaster

Coverage and use of PSF

7) Are PSFs in the village household/community based?
   - Household
   - Community based

8) How many PSFs are there that are in use in your village?

…………………………………………………………………………………………………

9) Where are the PSF located?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

10) How many families benefits from each of such PSF?

……………………………………………………………………………………………………….

11) Is the amount water provided through PSF adequate to serve the locals here?

- Yes
- No

If no, why?

……
……

12) Are there any social difficulties/conflicts when water is collected by communities from PSF?

- Yes

If yes, what and how is it settled?

……
……
……

- No

Water Quality

25. How is the quality of water from PSFs?

    - Good (Clear, odor free and does not taste saline)
    - Poor (Not so clear, odor and taste saline)

26. Has the quality of water remained that way since intervention?

    - Yes
    - No

    If no, how has it changed and why do you think it has?

……
……

27. Had there been any water quality testing since intervention?

- Yes
- No

28. Had there been any follow up by the organization after intervention?

    - Yes
    - No

29. Are there any possibilities for contamination of water?

- Yes

If yes how?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

- No

30. Is water from PSF available year round?

- Yes
- No

If not why and when?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

Management (Operation, Maintenance and Technical difficulties)

7. To your knowledge, had there been any minor/major technical difficulties in the PSFs since its intervention in Shymnagar?

- No
- Yes

If yes, what were they?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

Had they been repaired afterwards?

- Yes
- No

If yes, who did the repairing?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

8. How often do the care takers have to maintain such repairing or cleaning/ maintenance such as removing the sand layers and others)?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

9. Who now generally bears the maintenance/ repair cost and how much is spent?

…………………………………………………………………………………………………

……………………………………………………………………………………

10. Are locals motivated, to your opinion, adequately, to keep up the maintenance and operation of PSF and bear its repairing cost?

- Yes
- No

If no, why?

………………………………………………………………………………………………
………………………………………………………………………………………………

11. How long has the PSF been running since intervention?

………………………………………………………………………………………………
………………………………………………………………………………………………

12. Had there been any training/awareness program of communities for using PSF during or after intervention?

    - Yes
    - No

13. Are care takers/skilled labors available?

    - Yes
    - No

14. Are spare parts available in the market when necessary?

    - Yes
    - No

15. Are you able to seek assistance from organizations for any technical difficulties?

    - Yes
    - No

16. Have you addressed any of such as of yet?

    - Yes

    If yes, had they responded?
    ……………………………………………………………………………………………
    …………………………………………………………………………………………….

    - No

17. Is there any unwanted material generation from PSF?

- Yes

If yes, how is it discharged?
………………………………………………………………………………………………
……………………………………………………………………………………………..

- No

18. Are the intervention of PSF ongoing else where in your village?

    - Yes

If yes, where and by who?

……………………………………………………………………………………………………
……………………………………………………………………………………………………

- No
- I don't know

K. Suggestions and Way forward

6. Were the PSFs constructed after Aila disaster-resilient?

- Yes

If yes, why do you think so?
……………………………………………………………………………………………………
……………………………………………………………………………………………………

- No

If no, how do you think they could be made so?
……………………………………………………………………………………………………
……………………………………………………………………………………………………

7. To your knowledge, had there been any modification of PSF so far?

- Yes

If yes what and how is it better than regular PSF?
……………………………………………………………………………………………………
……………………………………………………………………………………………………

- No

8. Should there be more intervention of PSF in the region?

- Yes

If yes, why and where do you think they should be located?
……………………………………………………………………………………………………
……………………………………………………………………………………………………

- No

9. What, in terms of water quality and management should be done to enhance use of PSF in your area?

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