DRINKING WATER COLLECTION SYSTEM IN CYCLONE AFFECTED COASTAL VILLAGE OF BANGLADESH

A dissertation for the Degree of Masters in Disaster Management

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ABSTRACT

The implications of Cyclone in Bangladesh are the sea level rising, changes of climate patterns, man-made alteration of natural settings and main salinity in river water is increasing rapidly in the community of southern Bangladesh. After the cyclone SIDR and AILA surface water and also ground water on the southern side of Bangladesh became salty. People were also suffering from drinking water during the year. The most important factor is the lack of the collecting technique for drinking water.

In my research, I tried to find out the collecting technique to develop, which can help in gathering drinking water consistently, also better understanding of the process of salinization of drinking water resources in Bangladesh. All the data from field study was being collected in two different unions. One was SUTARKHALI union and other is TILDHANGA union. So that we can actually understand the effects of cyclone damages and suffer from the shortage of drinking and safe water. As research methods, both secondary and primary sources were applied. The groups targeted to be interviewed were community people in the coastal community, officials of non-governmental and governmental organizations.

Efficient aspects for lack of drinking water are salinity, shrimp farming, and arsenic. In water, salinity is making the lives of people miserable. They have social, economic or physical consciences. There is some traditional strategy regarding the collection system of drinking water. This knowledge is based on common sense and experience, but does not have any engineering basis. During the year they can collect the water from rain water, saline water and some point in a dew drop. In some process, they can use this water for drinking.

This thesis discussed a device for collecting drinking water called PANI [Purified Aqua for Numerous individual] which is based on regular knowledge and throughout some technology. Hopefully, these are helping for collecting drinking water throughout the year with salinity ingression, also economically affordable, easy accessibility, maximum use, portability and durability for the affected community of southern Bangladesh.

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BD	Bangladesh
BDT	Bangladesh Taka
BRAC	Building Resources Across Communities (formerly known as Bangladesh Rural Advancement Committee)
CC	Climate Change
CDMP	Comprehensive Disaster Management Programme
CPP	Cyclone Preparedness Program
CRA	Community Risk Assessment
CRH	Cyclone resistant house
DER	Disaster and Emergency Response
DMC	Disaster Management Committee
EI	Expert Interview
FGD	Focus Group Discussion
GOB	Government of Bangladesh
HH	Household
IWM	Institute of Water Modeling
KII	Key Informant Interviews
LGI	Local Government Institutions
MOFDM	Ministry of Food and Disaster Management
MOWR	Ministry of Water Resources
NGO	Non Governmental Organization
ORG	Organization
PO	Partner Organization
PRA	Participatory Rapid Appraisal
PSF	Pond sand filter
RWHS	Rain water harvesting system
SI	Salinity intrusion
UNDP	United Nations Development Fund
WAB	Water Aid Bangladesh
WS	Water Supply
WHO :	World Health Organization

1 CHAPTER 01: INTRODUCTION

1.1 Introduction

Bangladesh is considered as one of the most susceptible countries of the world to climate change and sea level rise. The current population of Bangladesh is 164,482,410 with an area of approximately 130,172 Km2 (50,260 sq. miles) (htt). Bangladesh is predominately rich, fertile flat land. Most parts of Bangladesh are less than 12 m (39.4 ft) above sea level, and it is estimated that about 10% of the land would be flooded if the sea level were to rise by 1 m (3.28 ft). The country has 700 rivers and 8,046 km (5000 miles) of inland waterways. There are a number of environmental issues and problems that are hampering the development of Bangladesh. This country has suffered from devastating tropical cyclones frequent, originating over the Bay of Bengal, in the periods of April to May and September to November. Due to the economic loss was huge, e.g. in two consecutive Cyclone Sidr'2007 damage was estimated at $1.7 billion (Ahmad, et al., 2008) and Cyclone Aila'2009 damage was estimated at US$ 269.28 million (Xinhua, 2009). The coastal area of the Ganges delta in Bangladesh is characterized by tides and salinity from the Bay of Bengal. Increasing salinity is a common phenomenon in the coastal belt day by day. Seventy percent of 2.35 million hectares (Sharma, 2012) of land within the Khulna and Barisal Divisions are affected by a different range of salinity. Salinity is such an ecological problem which is expected to exacerbate by climate change and sea level rise in the future.

1.2 Background of the study

The geography of Bangladesh is divided into three regions. The country is formed by a delta plain at the confluence of the Ganges (Padma), Brahmaputra (Jamuna), and Meghna Rivers and their tributaries. The country is extremely vulnerable to flooding, cyclone, tidal surge, salinity intrusion, earthquake, drought and beach erosion. Unique geographic location and high frequency of natural disasters are reasons for uncountable losses of life and assets. The country has been subjected to successive cataclysmic events in many structures, especially cyclonic tempests and storm surges. From 1797 to 1998, 67 noteworthy tornado tempests and stormssurges have been accounted for. These demonstrate that Bangladesh is inclined to visit ruinous tropical typhoons related with storm surge, especially in pre-storm months of April-May and post-rainstorm months of October-November. These storms can cause great damage and loss of lives. (Miyan)The impact of natural disasters is greater on coastal communities

due to their vulnerability intensity of the hazard. A widespread risk in the coastal zone is a reduction of freshwater flow from upstream, salinization of groundwater and fluctuation of soil salinity. The main reason behind the salinity in this area is Sea level rise. The higher salinity level impacts affect farming, aquaculture, and local and modern water utilize this. This is how around 60% land of this area is covered with salinity and the process is going on every day. (Miyan)

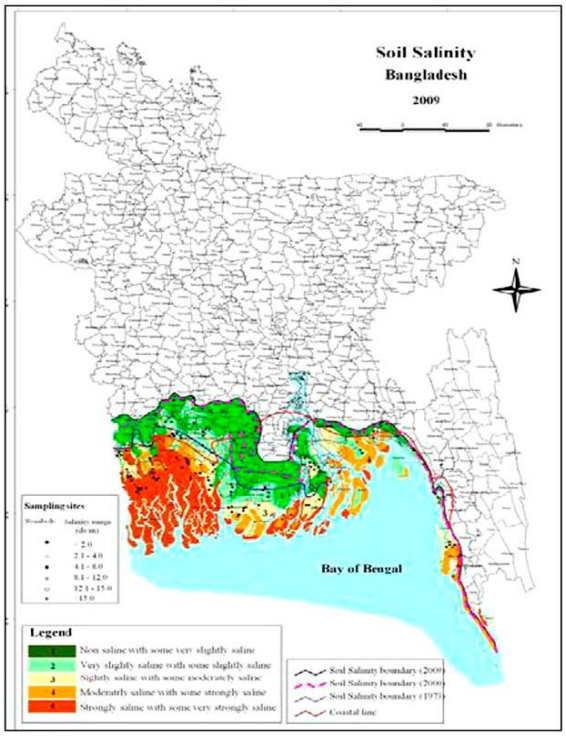


FIG: 1.1 Map of the soil salinity in Bangladesh

[www.ezilon.com/maps/images/asia/Bangladesh-physical-map.gif]

One of the major natural vulnerabilities of these communities has been found to an outrageous shortage of drinking water, as these are loaded with salinity. As a result of other natural disasters such as sea level rise, cyclones, flood, land erosion brings saline water from the ocean and blend with the ground water. As saline water blend with ground water and unsustainable utilization of ground water, individuals are experiencing different sorts of medical issue, for example, hypertension, diarrhea, cholera, and others. (Mustari & Karim, 2014)

River water with high levels of salinity, which used for drinking purpose, may have numerous impacts on the health of the human and the livestock. The fundamental effect of expanding saltiness at the social level is the loss of a generation and income. Poverty is intense here. The essential human needs are an unavoidable issue for them. (Mahmuduzzaman, Ahmed, Nuruzzaman, & Ahmed, 2014). It is very important to focus on dealing with salinity intrusion after the cyclone and also trying to improve the technique of drinking water collection use by the community.

1.3 Justification of the Study

Disaster statistics show that the frequency and intensity of extreme natural events have been increasing in recent years (UNDP, 2004). Additionally, global climate change and sea level rise may affect low-lying and coastal countries displacing millions of people from their homes, occupations, and livelihoods (World Bank, 2007). Bangladesh has around 160 millions of people is highly vulnerable to climate change and sea level rise (Rabbani & M. G., 2009). It is the world's third most vulnerable country to sea-level rise in terms of the number of people, and among the top ten countries in terms of percentage of people living in low-lying coastal zones (Miyan). In the last 10 years, Cyclone Sidr'2007 and Cyclone Aila'2009 was the most devastating. Most the Southern parts of the coastal zone are affected. This devastating disaster caused killed many people and caused huge loss of properties and infrastructure, affect huge damages in agriculture, fisheries, forestry, health, water supply and sanitation.

Millions of people in the coastal areas of Bangladesh are under threat of climate change and climate variability issues. According to a recent report, over 35 millions of people will be displaced from 19 coastal districts of Bangladesh in the case of the 1-meter sea level rise in this century (Rabbani & M. G., 2009). One of the major problems was the lack of safe drinking water. There is no deep tube well and also because of salinity in all the surface water, they didn't get drinking water. After the cyclone SIDR and AILA surface water and also ground water on the southwest side of Bangladesh was affected by salinity. This salinity intrusion after cyclone becomes a burden for the coastal community and creating adverse social, physical, economic and environmental impacts. The decrease in fresh water and salinity intrusion along with a soil quality reduction, slow down the plant growth and reduce productivity that put an adverse effect on biodiversity and the wildlife.

The water is not usable for household purposes if salinity is higher than 1ppt, however, it is as yet positive for harvest and domesticated animal agribusiness unless salinity surpasses 2ppt. Some freshwater aquaculture has been as yet conceivable when the salinity is beneath 4ppt. Subsequent to the catastrophe, affected areas experienced significant water scarcity with high saline levels found in groundwater. Therefore, people dependent mostly on surface water bodies, but the cyclone resulted in saline intrusion over the surface water resources making them unfit for drinking. Before Aila and Sidr people used surface water sources (PSF), tube well water and rain water, as their primary sources for drinking water. Immediately after the adversity, people were dependant on water trucking by the government

and-NGOs. 40% of drinking water ponds of the Polder areas and 100% of affected areas contaminated with saline water. Approximately 10% of the ponds have been de-watered and 90% of the tube wells were submerged.

Rationalized aspects for lack of drinking water are salinity, shrimp farming, and arsenic. The Southwestern zone ground water aquifer is contaminated with salt above permissible levels at various places. In Bangladesh, the official permissible threshold level of salt in ground water is 600 mg/l chloride solution, which is higher than elsewhere. But for the coastal districts, due to the unavailability of good water, the permissible level is set at 1,000 mg/l. Increasing salinity is a common phenomenon in the coastal belt day by day. Seventy percent of 2.35 million hectares (Sharma, 2012) of land within the Khulna and Barisal Divisions are affected by a different range of salinity.

The study communities in this research are Dacope Upazila of Khulna District, two villages named Bainpara from Sutarkhali union and Botbotia from Tildanga union had badly affected by Cyclone SIDR [November 2007] and AILA [May 2009]. After the field survey and affected area, visit in Khulna, one of the important southern regions of Bangladesh, it was comprehensible that water salinity is making the lives miserable. Communities are suffering from a drinking water crisis. Yet, communities have their traditional way of coping with this in a long time. The technological strategy was also looked at.

Now the emergence of finding out a technique, which can help for collecting drinking water throughout the year, even in disaster period is severe. This research also goes into a deeper analysis to find out some techniques.

1.4 Objective of the Study

1.4.1 Overall Objective

The broad line objective of this research is combining the traditional knowledge of collecting drinking water with the technology strategy to determine and identify potential alternatives available to establish drinking water by modifying the saline water of the affected community of southern Bangladesh.

1.4.2 Specific Objectives

The specific objectives include the following:

1. To consider the causes and effects for lack of drinking water
2. To analyze and record flow existing traditional and technology strategies and practices at different levels of community to collection of drinking water
3. Focus on the collecting technique to develop, which can help in gathering drinking water consistently, also better understanding of the process of salinization of drinking water resources in Bangladesh

1.5 Research question

What is the technique of collecting drinking water for this salinity ingression, which is also economically affordable, easy accessibility, maximum use, portability and durability for the affected community of southern Bangladesh?

1.6 Limitation of the research

Although this research was sensibly prepared, I am still aware of its limitations and shortcomings. Due to time constraint and weather condition, small periods of time spent with the community.

- The availability of information, easy access to primary data and information, finding the right people for additional guidance.
- The population of the interview and FGD is small, only twenty-five local people might not represent the majority of communities.
- Because of time constraints, the small study area was considered. As a result, the study area might not be representative enough.

2 CHAPTER 02: LITERATURE REVIEW

This chapter is based on the review of secondary data and documents which are based on this topic. The literature review provides information on the state of disasters in Bangladesh, especially cyclone and salinity.

2.1 Disasters

A disaster is an event, natural or man made, sudden or progressive, that seriously disrupts the functioning of a society, causing human, material or environmental losses of such severity that the affected community has to respond by taking exceptional measures.

(Vulnerability+ Hazard) / Capacity = Disaster

Disasters are often classified according to their speed of onset (sudden or slow), or according to their cause (natural or man-made).

2.2 Types of Disasters

Natural hazards are naturally occurring physical phenomena caused either by rapid or slow onset events which can be

Geophysical : Earthquakes, Landslides, Tsunamis And Volcanic Activity

Hydrological: Avalanches And Floods

Climatological: Extreme Temperatures, Drought And Wildfires

Meteorological: Cyclones And Storms/Wave Surges

Biological: Disease Epidemics And Insect/Animal Plagues

Environmental Disasters : Sea Level Rise, Desertification, And Climate Change

Technological Or Man-Made Hazards : Complex Emergencies/Conflicts, Famine, Displaced Populations, Industrial Accidents And Transport Accidents

This can include environmental degradation, pollution, and accidents.There is a range of challenges, unplanned-urbanization, under-development/poverty as well as the threat of pandemics, that will shape humanitarian assistance in the future.

2.3 Disasters in Bangladesh

Bangladesh is a disaster-prone country of an area of about 1,47,570 sq. km. with a population nearing 140 million. Major disasters that occur in Bangladesh are the tropical cyclone, tidal bore, flood, tornado, river bank erosion, earthquake, etc. A large number of poor people are to live in vulnerable areas of the southern part of Bangladesh. The vulnerability is so miserable that they have to go and settle in the newly created land in Bay of Bengal and its surrounding areas which are occasionally hit by the tidal bore or devastating cyclone. Realization of this reality, the Government of Bangladesh has undertaken a lot of plans and programs for disaster reduction through disaster management (Disaster Report, 2014)

2.4 Definition of Cyclone

A storm or system of winds that rotates about a center of low atmospheric pressure, with a counterclockwise (northern hemisphere) or clockwise (southern hemisphere) circulation; a depression. The main effects of tropical cyclones include heavy rain, strong wind, large storm surges at landfall, and tornadoes. The destruction from a tropical cyclone depends mainly on its intensity, its size, and its location (Effects of tropical cyclones).

2.5 Cyclone in Bangladesh

Bangladesh, because of its one of a kind geographic area, experiences tropical cyclones as often as possible. The funnel-shaped, formed a northern bit of the Bay of Bengal causes tidal bores when cyclones make landfall because of which a huge number of individuals living in the coastal areas are influenced. During the years 1797 to 2016, Bangladesh has been hit by severe cyclones, 32 of which were accompanied by storm surges. (Khan). But the year 2007 (15-17 November) Severe cyclonic storm 'Sidr' causes immense damage in the southern part of Bangladesh; about 3000 persons killed. After that year 2009 (27-29 May), A severe

cyclonic storm 'Aila' attacked offshore 15 districts of the southwestern part of Bangladesh;' about 150 persons killed, 2 lac houses and 3 lac acres of cultivated land and crops losses.

2.6 After Cyclones the Situation Of Communities in Southern Bangladesh:

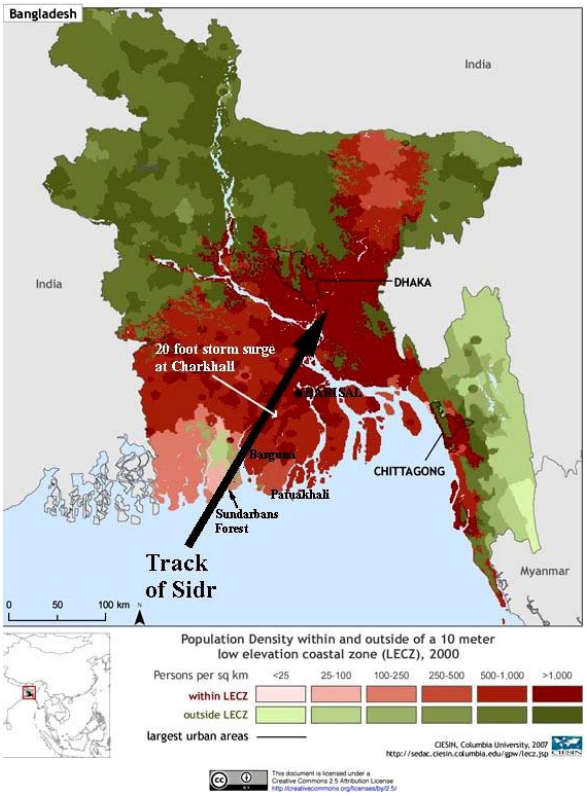
A few years ago, rivers were important sources of fresh water in the southwest coastal areas. But now intrusion of saline water from the sea into the islands is increasing salinity and scarcity of fresh water in rivers. After the cyclone SIDR and AILA surface water and also ground water on the southwest side of Bangladesh became salty. (Chowdhury, Hossain, Samsuddoha, & Khan, 2012) Recently, availability of saline free drinking water will be an existing issue in the coastal areas and this problem is expected to increase in the future.

People are suffering through the scarcity of pure drinking water because of the high level of the salinity. Their source of drinking water is Community Protected Pond, Pond Sand Filter, Rainwater Harvesting, tube well and also rivers. These collection points of drinking water are generally far away from the home.

FIG: 2.1 Bangladesh delta rising sea levels are changing the salinity of its water

[www.ezilon.com/maps/images/asia/Bangladesh-physical-map.gif

2.6.1 Cyclone SIDR at November, 2007



On 15 November 2007, Cyclone Sidr was attacked on the southwest coast of Bangladesh with winds up to 240 kilometers per hour in some areas, breaching coastal and river embankments, flooding low-lying areas and causing extensive physical destruction. Houses, roads, bridges, and other infrastructure were mostly damaged. Drinking water contaminated by saline water from tidal surges, and sanitation infrastructure was destroyed. (RASOOLDEEN, 2016) The impact of Cyclone Sidr was relatively moderate on high population density and higher poverty rates in coastal areas.

FIG: 2.2 Map of the cyclone SIDR in Bangladesh

[www.wunderground.com]

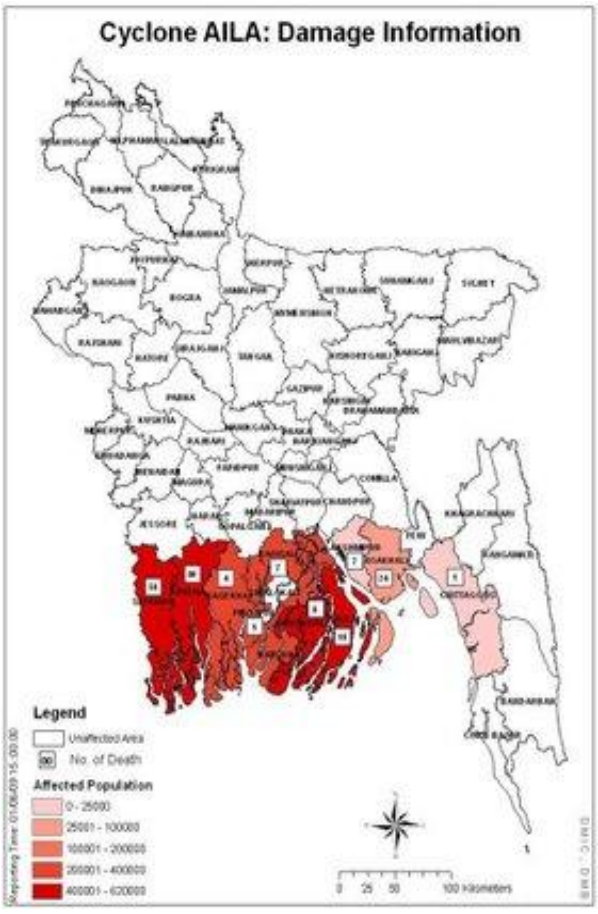
There was a high need of food items mainly rice, puffed rice, jiggery, drinking water, etc. Besides that, fertilizers, and other agricultural inputs were also a need at that time, but people mostly suffered for food and need of drinking water as most of the pond they used for drinking water became inundated with salinity.

The primary impact of Cyclone Sidr on water supply and sanitation facilities was in rural areas. Drinking water sources like tube wells and ponds in many communities were contaminated by saline water. Some of the area groundwater sources were contaminated by arsenic and salinity in shallow aquifers (Bangladesh, 2008). In most places, tube-wells don't work because of salinity in the shallow and deep aquifer levels, leaving most people dependent on surface water for drinking and cooking. Moreover, after the Cyclone SIDR, surface water on the southwest side of Bangladesh became salty. So, the availability of drinking water is one of the major problems in the saline prone area.

FIG: 2.3 Pictures Illustrates of the Damage by Cyclone Sidr in Bangladesh.

[Pictures taken by LHCB - ACT International, www.flickr.com/photos/uncultured, www.theipinionsjournal.com]

2.6.2 Cyclone AILA at May, 2009



On 27 May 2009, Cyclone Aila was stroking the Coastal area of Bangladesh. The cyclone Category 1 storm and 120km/h Wind were breaching coastal and river embankments, flooding low-lying areas and causing extensive physical destruction. Aila was causing extensive flooding that has still not retreated. Most of the pond, people used for drinking water became swamped with saline water. Aside from the problems caused by Aila, most of the groundwater in the area has become salty, so tube wells cannot be used. So, people faced a huge drinking water crisis in these areas. People walk up to 1.5 kilometers to reach the pond while others arrive in boats to transfer the water to neighboring villages. (Ahmad, et al., 2008)

FIG: 2.4 Map of the cyclone AILA in Bangladesh

[Disaster Management Information Centre of Bangladesh]

Affected areas experienced significant water scarcity with high salinity levels found in groundwater. Therefore, people dependent mostly on surface water bodies, but the cyclone resulted in saline intrusion over the surface water resources making them unfit for drinking.

Before Aila, people used surface water sources (PSF), tube well water and rain water, as their primary sources for drinking water.

FIG: 2.5 Picture Illustrates the condition of Aila affected village, October 2010

[Pictures taken by Tahamina Rahman]

Immediately after AILA, people were dependant on water trucking by the government and-NGOs. 40% of drinking water from existing ponds of the Polder areas and 100% of affected areas contaminated with saline water. Approximately 10% of the ponds have been de-watered and 90% of the tube wells were submerged. Women spent an average 4-5 hours a day collecting water, often walking 2-3 km to reach the nearest safe water sources/collection point. (Ahmad, et al., 2008)

People are forced to drink unsafe water or spend their limited financial resources on the collection of safe water or purchasing drinking water. Five years after Aila happened, still many of the victims haven't gotten enough food, safe drinking water and a means to make a living. (Sharma, 2012) After the Cyclone AILA, the surface water and also ground water on the southern side of Bangladesh have become salty. Lacking drinking water is one of the key issues in the saline prone area.

2.7 Salinity

Salinity is a measure of the content of salts in soil or water. Salts are highly soluble in surface and groundwater and can be transported with water movement. Salinity affects production in crops, pastures, and trees by interfering with nitrogen uptake, reducing growth and stopping plant reproduction. The most significant off-site impact of dryland salinity is the salinization of previously fresh rivers. This affects the quality of water for drinking and irrigation—with serious economic, social and environmental consequences for both rural and urban communities. Salinity can also affect people directly in a number of ways including:

- Cost to rural communities of declining population
- Loss of business (both existing and potential)
- Cost of rural restructures when farms become unprofitable
- Increased health problems due to stress on families affected by a change.

Salinity may also indirectly affect people by reducing the quality of the natural environment (Impacts of salinity, 2013)

2.8 Causes of salinity increase:

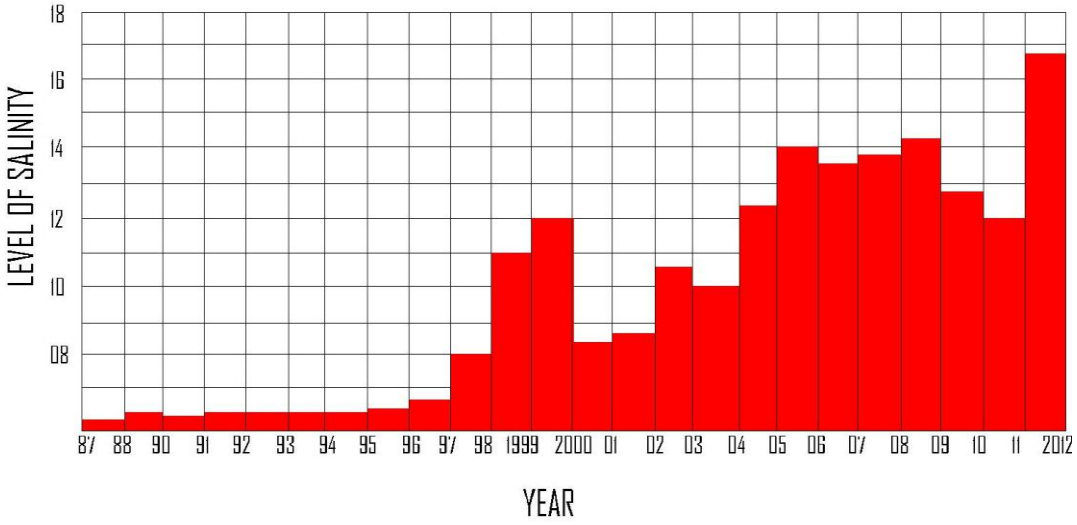
Salinity is expected to be exacerbated by-

- ✓ Climate change and sea-level rise
- ✓ Expansion of shrimp farms

Impacts Of Salinity:

10% more land will be saline-affected and intensity will be increased
Decreases availability/productivity of agricultural land
Increased food insecurity as natural growing species disappear
Serious scarcity of safe drinking water
Loss of biodiversity, decrease in tree species and freshwater fish
Creates socioeconomic problems, generally women are more vulnerable

Table-2.1 Increase in Salinity with respect to time in the southwest



Source: Based On Literature Review

Reduce the availability of fresh water and salinity intrusion along with soil quality depletion slows down the plant growth and reduce productivity that put an adverse effect on biodiversity and the human life. River water with high levels of salinity, when used for drinking purpose, may have numerous impacts on the health of the human and the livestock. The high level of salinity in drinking water might cause an increased rate of preeclampsia and gestational hypertension in pregnant women.

2.9 The current situation of the cyclone affected community of southern Bangladesh due to the presence of high rates of saline in water:

This salinity intrusion and aspects for lacking access to safe drinking water is a significant barrier to improving the health and well being of the people and increasing poverty in the southwest coastal zone of Bangladesh. Salinity in ground and surface water is the main cause of this problem. The effects are negative for health, social and economic outcomes for the local population.

2.9.1 Physical Consequences

Now Bangladesh is facing another environmental and health threat due to man-made and natural factors increased salinity. Everyone in the coastal area was found to be suffering from

one or more saline water-related disease. Increased salinity of drinking water is likely to have a range of health effects, including increased hypertension rates. Large numbers of pregnant women in the coastal areas are being diagnosed with pre-eclampsia, eclampsia, and hypertension. Women, explaining their bitter experiences about menstrual hygiene management, reported that saline water creates pain during menstruation. People have various kinds of skin diseases. Reproductive problems for pregnant women are common phenomena for salinity in drinking water. (Ahmad, et al., 2008)

2.9.2 Social Consequences

There are so many social consequences of salinity. Mostly Women are usually required to collect drinking water from distant sources. This may take three to four hours a day. When they go out to collect water, sometimes women are harassed by men. This is mostly an uneasy feeling and threat while collecting water from distant sources. The skin of girls becomes rough and unattractive due to the use of saline water. These things are creating the problem during the marriages of a girl. These girls become a burden for their families, which is not acceptable. (CHOWDHURY, HOSSAIN, SHAMSUDDOHA, & KHAN, 2012)

2.9.3 Economic Consequences

Sometimes a poor family cannot afford to collect water due to sickness so they have to buy water from water vendors at Taka 10 per pitcher, which spend 300 taka per month when their monthly income is maybe 500 tk – 1500 tk. Therefore, they have no choice but to use saline water for drinking purposes. Also, the other options have become so expensive. Over 30 per cent of the net available cultivable land of Bangladesh is located in the coastal areas, which is not being utilized for crop production, mostly due to soil salinity. People here have been facing the hard reality of drinking saline water for decades. As a result, they have some serious health diseases. They have to spend lots of money for overcoming these diseases. (Ahmad, et al., 2008)

2.10 Integration of traditional and technological practice of water collection

Communities have some traditional practice to collect the drinking water. Most of the time these are working efficiently and also cost effective. Recent days some technological contribution uses as tools to scrap against the salinity. These technologies are making easy to use fresh drinking water.

PROTECTED POND	**A** protected pond in a community can provide water for drinking purpose with minimal treatment and for other domestic uses without treatment. This pond uses only for the drinking purpose. This Traditionally, rural water supply, to a great extent, was based on protecting ponds before, during early stage the installation of tube wells. During the dry season, a huge number of ponds dry up. In order to maintain good quality water, the protected pond shall not receive surface discharges or polluting substances and should only be replenished by rain and ground water filtration.

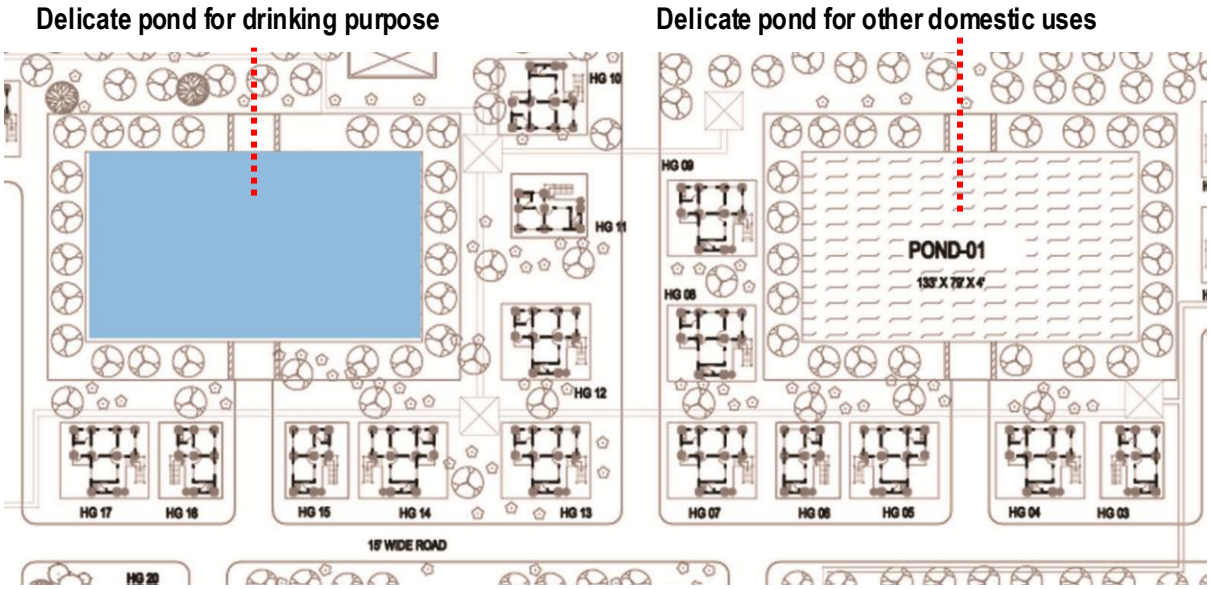


FIG: 2.6 A protected pond in the coastal village of Bangladesh [www.shushilan.org, Redrawing By Ar. Afsana Latif]

DUG WELL/RING WELL	**D**ug well is the oldest method of groundwater withdrawal for water supplies. Usually no special equipment or skill is required for the construction of dug wells. It is very difficult to protect the water from the dug well from bacterial contamination. Percolation of contaminated surface water is the most common route of pollution of good water (IMPLEMENTATION GUIDELINES for Ring-Well, 2006).

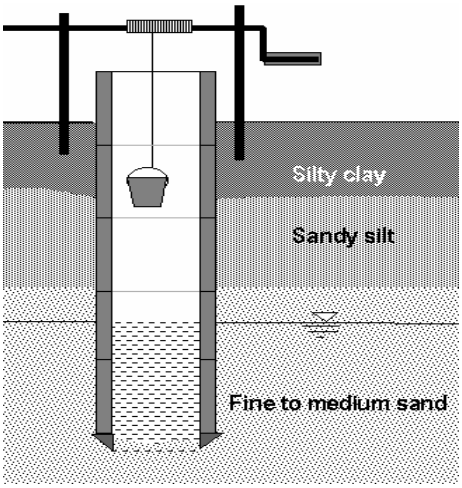


FIG: 2.7 A conventional dug well [users.physics.harvard.edu]

RAIN WATER COLLECTION IN LOCAL TECHNIQUE	**B**angladesh received heavy rainfall during the rainy season. The quality of rainwater is comparatively good. Local materials and craftsmanship can be used in the construction of a rainwater system. No energy costs are incurred in running the system and ease of maintenance by the owner/user (Rana).

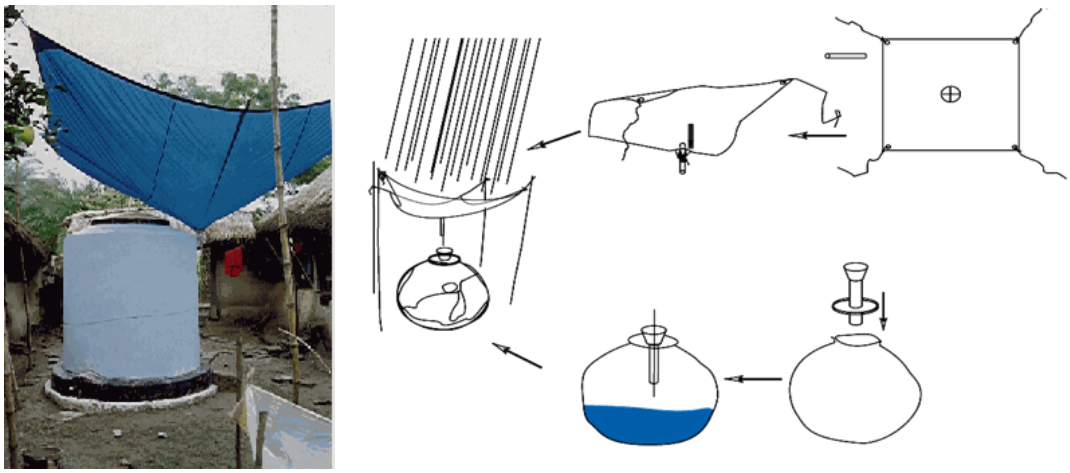


FIG: 2.8 Local techniques of rain water collection

POND SAND FILTER	**A**n alternative and popular option of potable water supply in the coastal belt and saline prone areas is the Pond Sand Filter (PSF). It is a package type slow sand filter unit developed to treat surface water, usually pond water for domestic water supply. The slow sand filter is installed near or on the bank of the pond, which does not dry up in the dry season. The problems encountered are low discharge and difficulties in washing the filter beds. Since these are small units, community involvement in operation and maintenance is absolutely essential to keep the system operational (IMPLEMENTATION GUIDELINES for Pond Sand Filter , 2006).

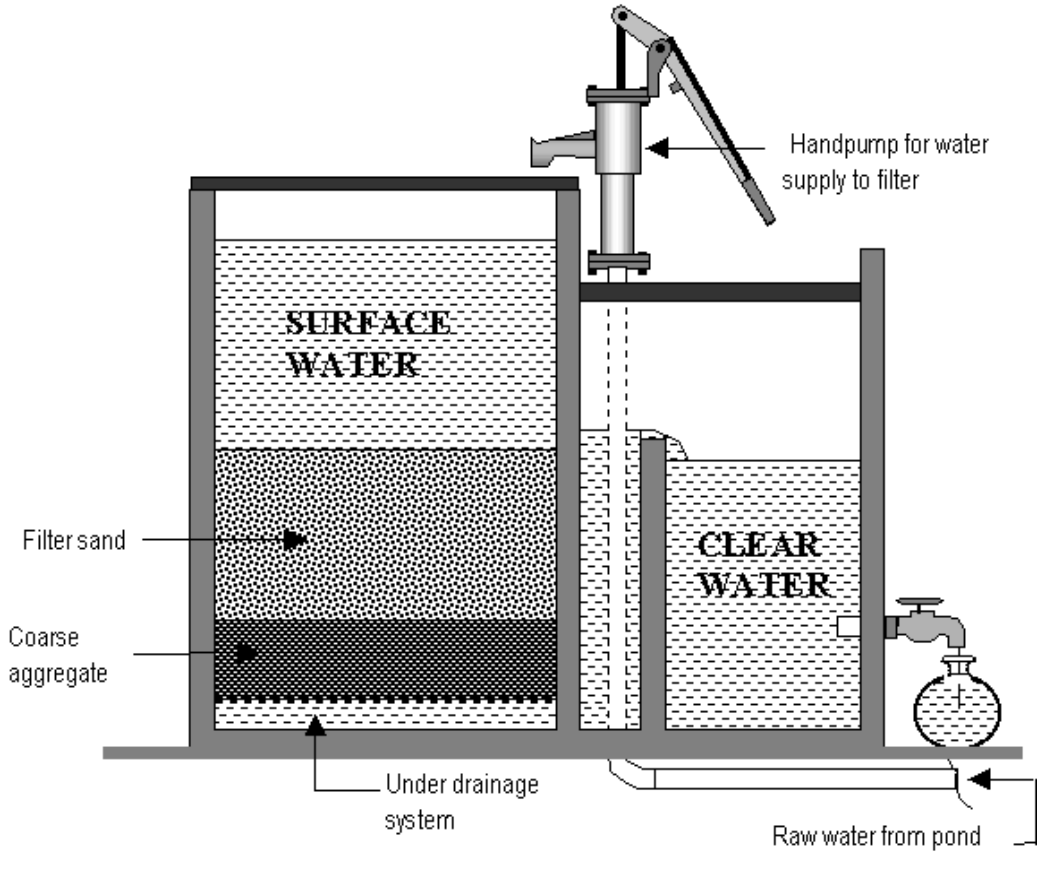


FIG: 2.9 Pond

Sand Filter for Treatment of Surface Water

DEEP TUBE WELL	**D**eep tube wells technologies have been designed and installed in the coastal areas to collect water from very shallow aquifers formed by displacement of saline water by fresh water. These tubewells installed in those protected deeper aquifers are producing saline safe ground water. In this process people have to walk long distances to collect safe water. The identification of areas having suitable deep aquifers and a clear understanding of the mechanism of recharge of these aquifers is needed to develop deep tubewell based water supply systems in Bangladesh (IMPLEMENTATION GUIDELINES for Tubewells , 2006).

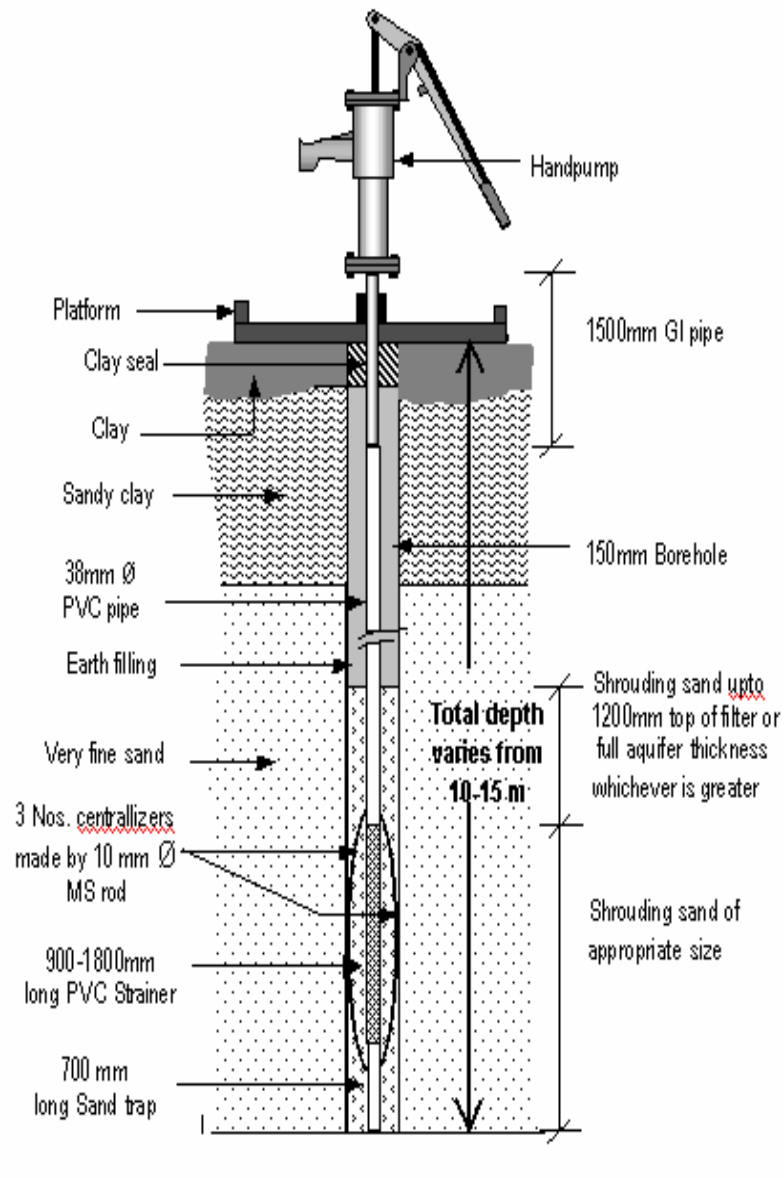


FIG: 2.10 Deep tubewells

RAINWATER HARVESTING	**I**n Bangladesh, rainwater collection is seen as a viable alternative for providing safe drinking water in saline affected areas. Components of rainwater harvesting system are locally used in Bangladesh • Catchment , Guttering • Flushing system • Water collection point • Storage reservoir

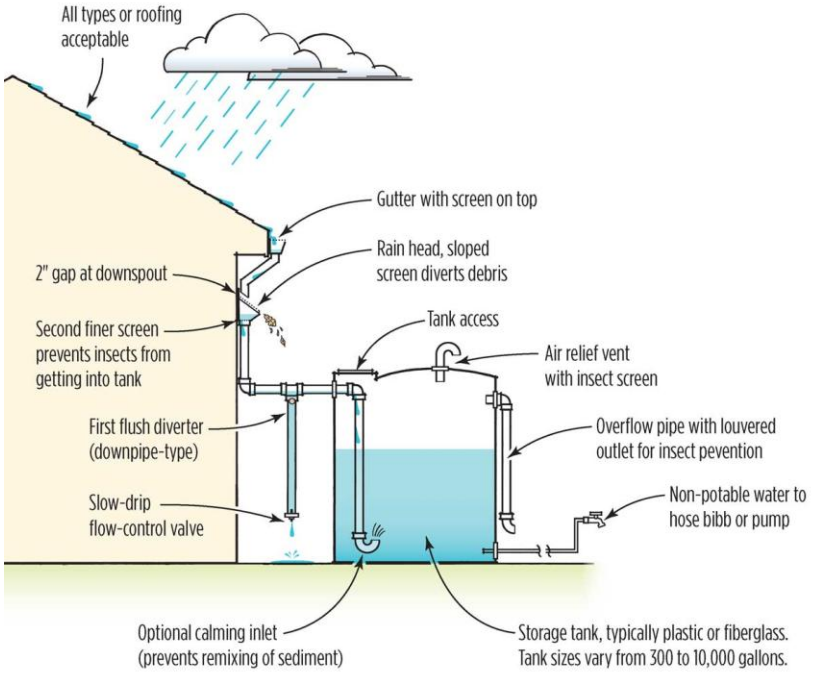


FIG: 2.11 A rainwater harvest system

2.11 What is Desalination?

The process that extracts, minerals from saline water. More generally, desalination refers to the removal of salts and minerals from a target substance. Due to its energy consumption, desalinating sea water is generally more costly than fresh water from rivers or groundwater, water recycling, and water conservation. However, these alternatives are not always available and depletion of reserves is a critical problem worldwide (Desalination, 2017).

2.12 Water Desalination Processes

Water desalination processes separate dissolved salts and other minerals from water. Membrane separation requires driving forces including pressure (applied and vapor), electric

potential, and concentration to overcome natural osmotic pressures and effectively force water through membrane processes. The traditional process used in these operations is vacuum distillation—essentially boiling it to leave impurities behind. (Desalination & Water Purification Technologies, 2010)

Solar Distillation Of Saline Water: The basic concept of using solar energy to obtain drinking water able saline water is really quite simple. Water left in an open container in the backyard will evaporate into the air. The purpose of a solar still is to capture this evaporated water by condensing it onto a cool surface using solar energy to accelerate the evaporation (Desalination, 2017).

Desalination by Reverse Osmosis: Desalination by Reverse osmosis is a separation process used to reduce the dissolved salt content of saline water. All desalination processes involve three liquid streams: the saline feed water (brackish water or seawater), low-salinity product water, and very saline concentrate (brine or reject water). The saline feed water is drawn from oceanic or underground sources. It is separated by the desalination process into the two output streams: the low-salinity product water and very saline concentrate streams. The use of desalination overcomes the paradox faced by many coastal communities, that of having access to a practically inexhaustible supply of saline water but having no way to use it. Although some substances dissolved in water, such as calcium carbonate, can be removed by chemical treatment, other common constituents, like sodium chloride, require more technically sophisticated methods, collectively known as desalination. The capital and operational costs of the reverse osmosis system would be relatively high. (Desalination & Water Purification Technologies, 2010)

The reasons for this research, to give a method of gathering drinking water, which will be easy to understand answer for this saline water issue in the coastal zone. For this community has been characterized as a gathering of individuals sharing normal beliefs, assets, condition, and aspirations while living in the same geographical location.

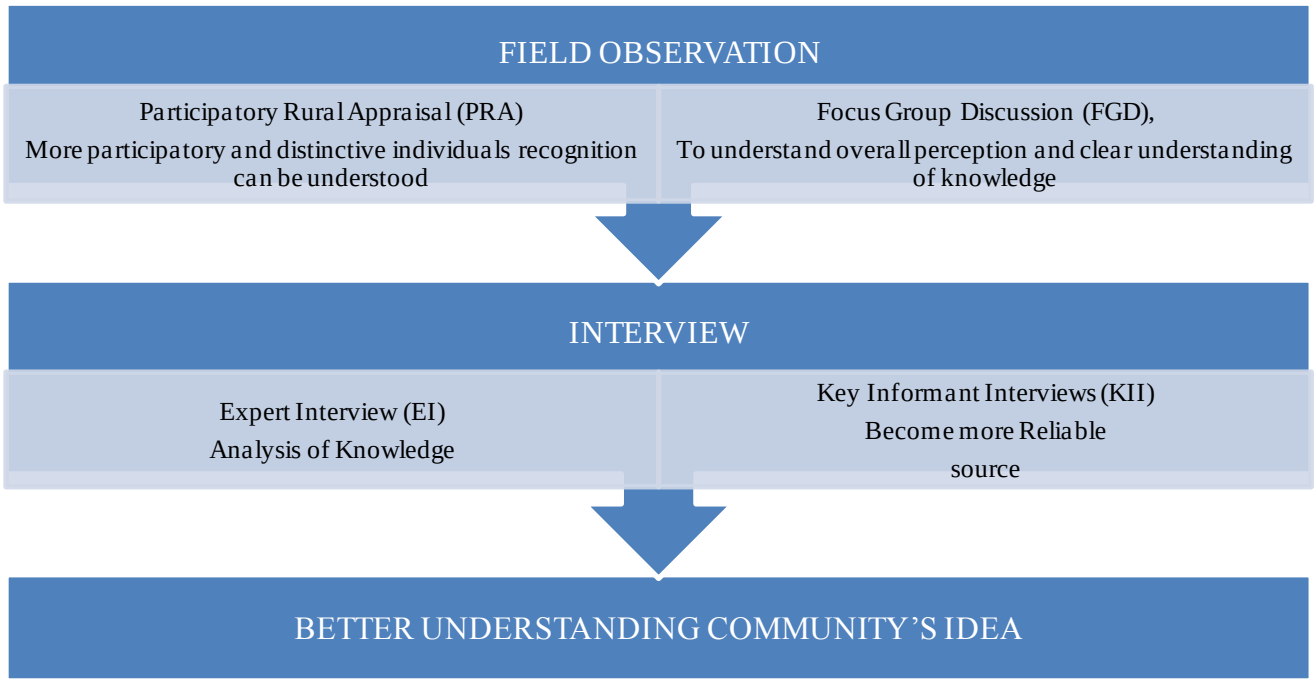
3 CHAPTER 03: METHODOLOGY AND APPROACHES

This chapter will be focusing on the methodology used to conduct the research. While describing the various steps (framework of study tools, sampling design, and procedure, sample size determination, data collection, processing, and analysis) towards the completion of the research. The study mainly focused on cyclone and essential to improving the living condition for suffered from salinity intrusion. Also looking for a Sustainable solution for safe drinking water in the saline affected community.

3.1 Framework of the Study

In this thesis, both quantitative and qualitative data are used for this research. A literature review has been conducted on the issue to identify any gaps and to derive any recommendations of good practice being followed externally. Further information has been collected from different sources like books, websites, reports, and different organizations, NGOs, internet and newspaper etc conducted. The methodology of this study confined to field observation, Focus Group Discussion (FGD), Expert Interview (EI), Participatory Rural Appraisal (PRA), Key Informant Interviews (KII), data presentation and analysis. For the better understanding community's idea and culture related to the water harvesting system is analyzed carefully.

Table-3.1 Methods of data collection



3.2 The study focused on the information

The study focused to assess the changes in the following areas:

1. What are the main reasons behind the increased level of salinity in water of Bangladesh?
2. How is this salinity affecting the regular life of the target area?
3. Essential to improving the living condition for suffered from salinity intrusion
4. People have been facing the hard reality of drinking saline water for decades
5. What is the established traditional method of collecting drinking water?
6. A sustainable solution for safe drinking water in saline affected community
7. What will be the alternative and user-friendly solution for this saline water problem in the affected area?
8. How to monitor the recommended solution in the target area?

3.3 Study Area Selection

As a study area of this thesis, Dacope upazila, was being selected from Khulna District. This area was badly affected by Cyclone SIDR [November 2007] and AILA [May 2009]. From this Dacope Upazilla, two villages named Bainpara from Sutarkhali union and Botbotia from Tildanga union was being selected through purposive sampling for conducting the study. Approximately, 65 participants, both man, and woman were selected for data collection in each union. For giving a better understanding of the situation of the site, All data were collected through survey sampling method from the village.

FIG: 3.1 District Map of Khulna division in Bangladesh

[http://www.lged.gov.bd/ViewMap2.aspx?DistrictID=35]

3.1 Data Collection Method

This research was based on both primary and secondary data. All the necessary data has been collected from various sources like observation, discussion, and online information. The methodology of this research paper has divided into three major parts, namely-

- Data Collection from the field and also from secondary sources;
- Data Analysis for appropriate system (Both quantitative and qualitative);
- Result and Recommendation;

3.1.1 Primary Data

The primary data was collected from field visits, focus group discussion, informal interviews, social mapping, vulnerability assessment, etc. It will be collected using questionnaire, interview, Participatory Rural Appraisal (PRA) tool such as Focus Group Discussion (FGD) and cross-check interviews with key informants. All data will be collected through survey sampling method from the village.

3.1.2 Participatory Rural Appraisal (PRA) and Focus Group Discussion (FGD)

During the study, total 11 FGDs was conducted to understand and find out appropriate rainwater harvesting systems with the household. FGD was being carried out among the major groups of the community. It incorporates male, female, and adolescent girls and approximately 6 participants were in each FGD which, was conducted among the community leaders. The final findings of both of FGDs were being unified in the report.

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FIG: 3.2 Focus Group Discussion (FGD) With Community People

3.1.3 Expert Interviews

A total of 15 EIs was conducted, of which two were held at the national level, three at sub district (Upazila) level, and ten at community (local) level. The experts were mostly people who worked in organizations and institutions involved in disaster, environment, water issues, and socioeconomic development or having vast practical knowledge on the issues covered under the study.

FIG: 3.3 Key Informant Interviews (KII) with Community People

3.1.4 Social mapping

Social mapping is an activity that looks to build up a social value that is communal to objects in a characterized region of living arrangement or all the more appropriately, a social scene. It was done in participation with the villagers of both unions. It revealed certain information like the settlement pattern, types of the drinking water collection method, total no of household, source of income of the households, areas of important places like schools and temples, the village path, cultivated areas, safe areas evacuate during the cyclone etc.

FIG: 3.4 Community Social Mapping

3.1.5 Livelihood Analysis

The Livelihood examination apparatus was understood the employment design in the study areas and the accessible regular, social and individual assets. It provides critical data with respect to the social structure and power circulation of those specific areas. In addition, it recognized the effect of disasters on the livelihoods of the community.

FIG: 3.5 Community Livelihood Analysis

3.1.6 Historical Profile

Historical profile mirrors the examinations of the past occasions and future situations and the imaginable effect on key sectors, for example, job, risks, vulnerabilities, adopting limits, and so on. This profile was furnished by maturing individuals as it bases past to the future bearing.

3.2 Secondary Data Collection

The Secondary data was collected from different sources like Literature review, websites, reports, and different organizations, NGOs, the internet, and newspaper etc conducted.

3.2.1 Collection of Maps

Maps were collected from internet websites, Shushilan, UNDP and Center for Natural Resource Studies (CNRS) etc.

3.2.2 Collection of Photographs

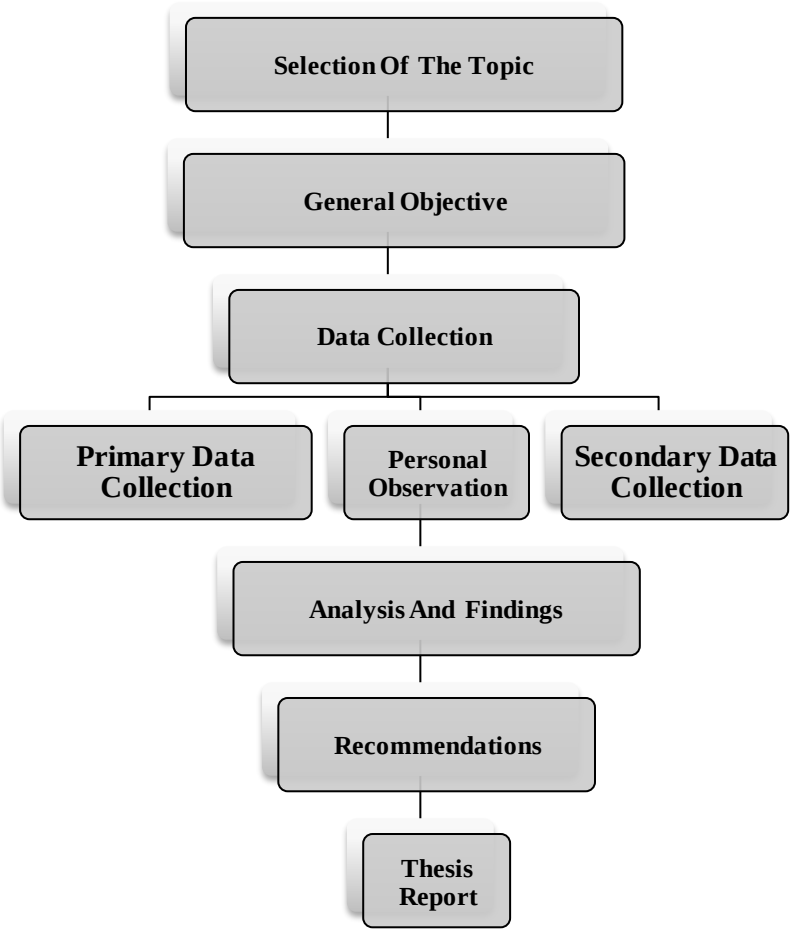
Some of these photographs were collected directly from field studies and some were from related literature and the internet websites. A few pictures were collected from Mrs.

Tahamina Rahaman, research assistant of Postgraduate Programs in Disaster Management, BRAC University.

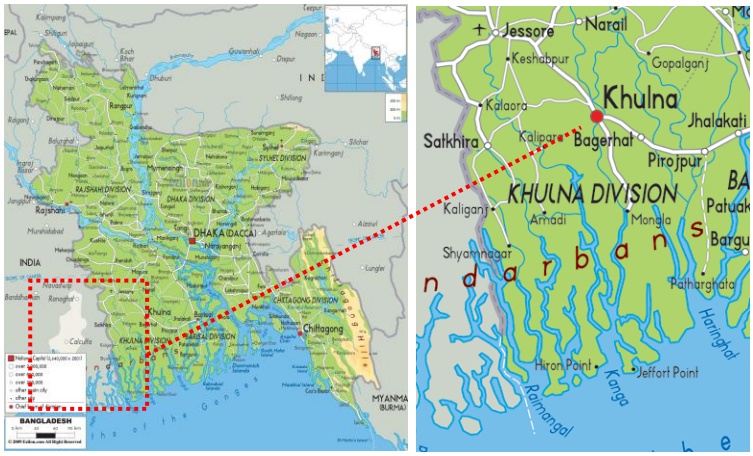
3.3 Activity Flow Chart

All the data both primary and secondary were collected from different sources have been analyzed separately. Finally, the result has been integrated and presented as maps, tables, and graphs and put in the report. Workflow of the study is shown in FIG 3.1. This shows the main input information and generated output from data collection and secondary data selection population by land cover distribution and comparison of the coastal area of Bangladesh. The whole methodology of the research is described below.

Table-3.2 Methodological Flowchart of the Study



4 CHAPTER 04: PROFILE OF THE RESEARCH AREA

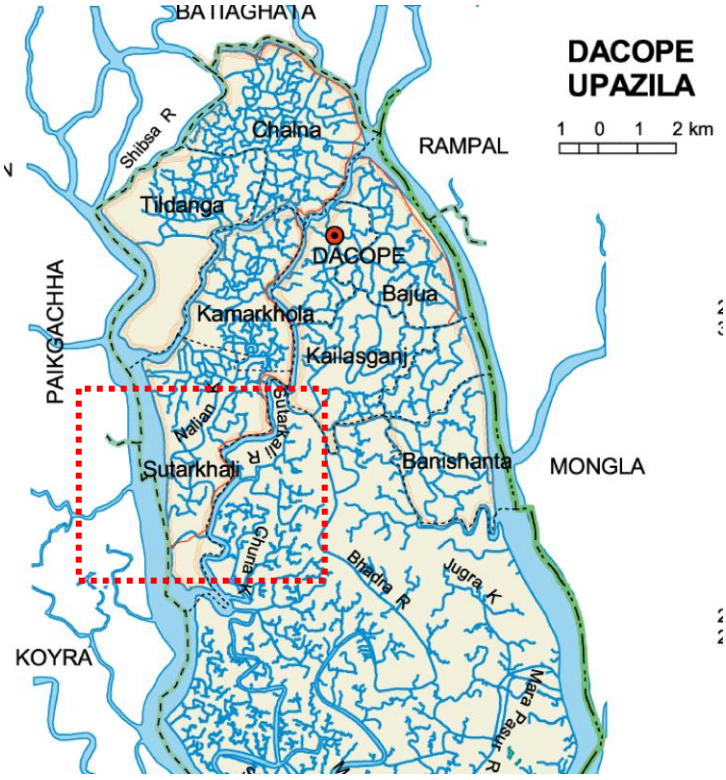


Geographically, Khulna Division is located in the southwest part of Bangladesh. The study area of the research work was held in Dacope district in Khulna. All the data from field study was being collected in two different unions. One was SUTARKHALI union and other is TILDHANGA union.

FIG: 4.1 Map of the Study Area (Khulna Division in Bangladesh)

[www.ezilon.com/maps/images/asia/Bangladesh-physical-map.gif]

4.1 Physical & Demographical development of SUTARKHALI union



In May 2009, Cyclone Aila affected the coastal belt of Southern Bangladesh. The union Sutarkhali under the Dacope upazila of Khulna district was affected, especially the Bainpara village. Populations of the village are 38,000. The Economic condition of the village is extremely poor. Most of the economic activities are seasonal and thus the villagers engaged in different types of activities in different parts of the year.

FIG: 4.2 Map of the Study Area, **SUTARKHALI** (Dacope Upazila)

[www.banglapedia.org]

After the attack by cyclone, houses, productive lands, embankment and other infrastructures such as schools, mosques, etc. were damaged and locked under water for a long time. They were also the sufferings of drinking water. The other parts of the country, hand tube well is considered as a source of drinking water. Here, in the study area, salinity made the people bound to use rainwater for drinking. Housing conditions had no separate kitchen and they cook in their bedroom. Most of the houses had golpata-fenced wall while only a bit more than 15% houses have tin-fenced. Maximum houses had an earthen floor some had wooden and 2% had brick made floor. Most of the houses had no latrine but some had unhygienic latrine (Katcha) and non-sealed. [17]

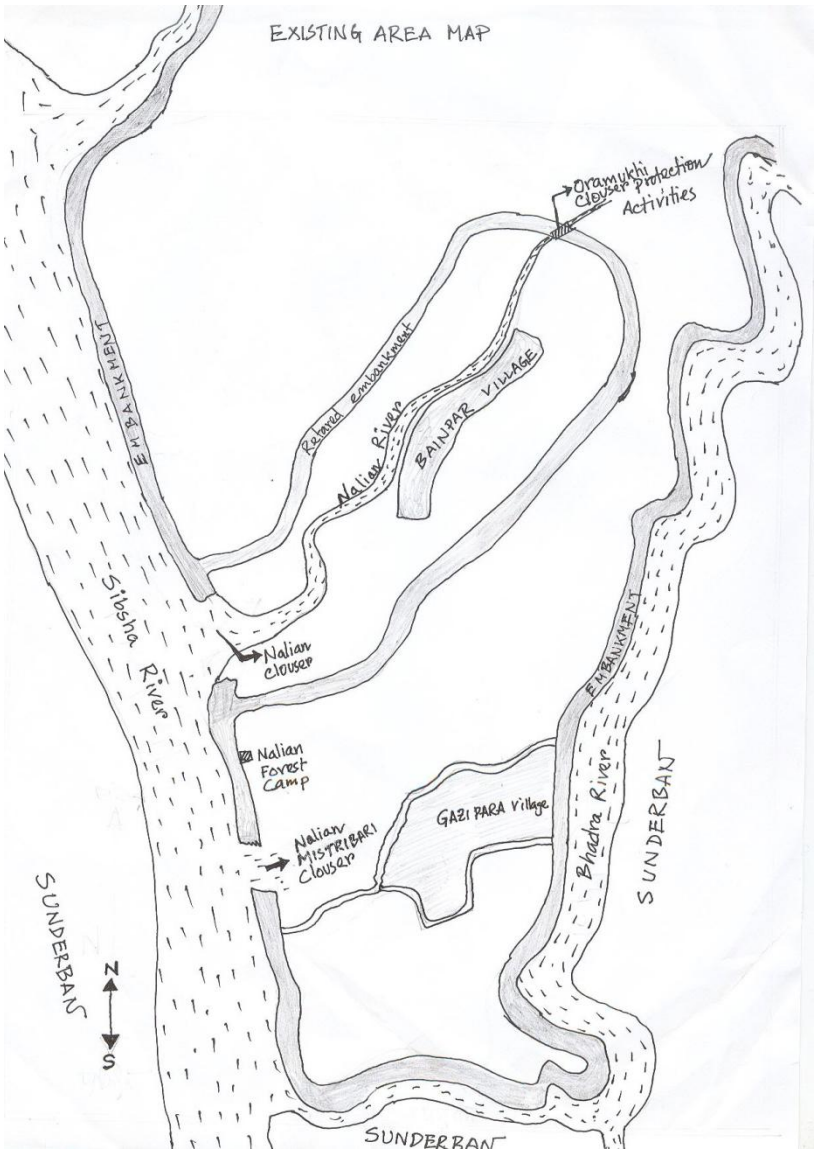


FIG: 4.3 Plan of existing Bainpara village [www.shushilan.org]

The main way of earning of every household is different sources such as carpenter/fishery, the collection of natural resources, service and wages, domestic animal and poultry. Total income on per day is 150 tk - 250tk. As long term effect of Aila, the scope of opportunity reduced, the lands became uncultivable due to salinity in water. Fishing occupation is also at stake due to the same reason. Wood cutter and honey collectors are much afraid to collect these natural resources due to tiger attack in Sundarbans.

FIG 4.4 Pictures Illustrates of the Bainpara village, October 2010 [Pictures taken by Tahamina Rahman]

Aila totally destroyed almost 80% of livelihood options, infrastructure, water and sanitation in the Sutarkhali union. Many national and international organizations came forward with emergency help for the people of the coastal area just after the commencement of Aila, but none considered about their permanent solution to get relieved from the long term impact of Aila.

Shushilan, UNDP, and Center for Natural Resource Studies (CNRS) immediately responded for constructing a disaster resilient habitat project for the 58 households in the Bainapara village of Sutarkhali union to ensure proper facilities with disaster resilient territory for vulnerable communities.

FIG: 4.5 Plan of the present Bainpara village [www.shushilan.org]

This project has been carried out the activities of second defense ring road construction, embankment repair with proper drainage. In Bainpara village are being developed, including some basic services such as Disaster resilient Rain Water Harvesting (RWH) for each family, Disaster Resilient Pond Sand Filter (PSF), latrine and wood saving oven for each of the families. In order to plan for proper landscaping for the houses and forestation activities with locally adapted species depending on soil condition.

FIG: 4.6 House design of present Bainpara village, 2012

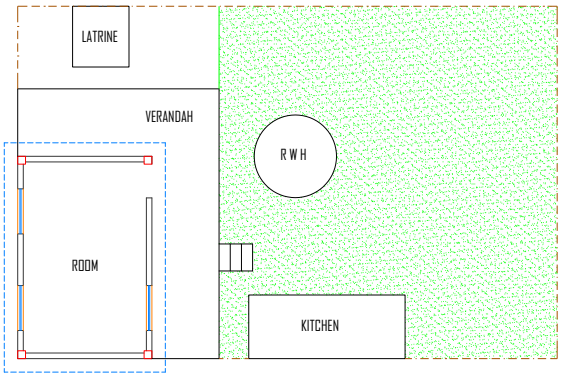


FIG: 4.7 Plan of individual House

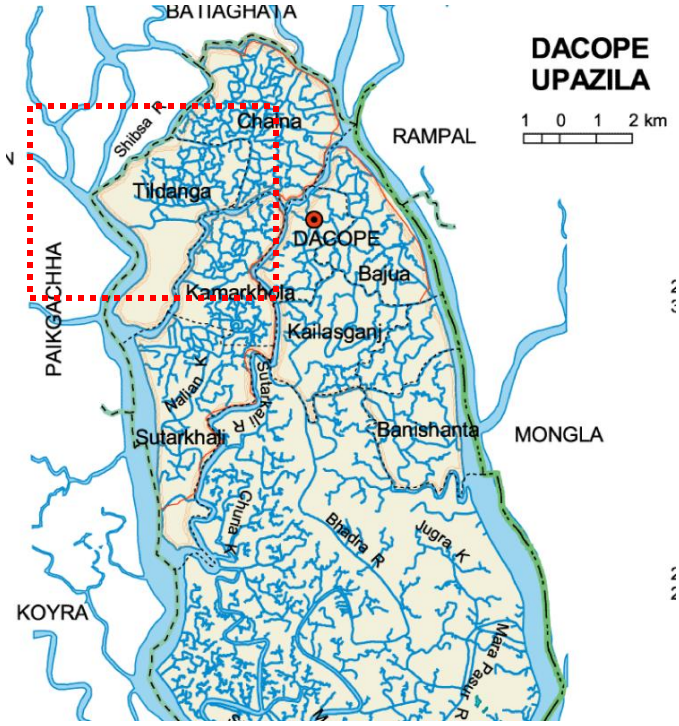
FIG: 4.8 Disaster resilient Rain Water Harvesting (RWH) of present Bainpara village, 2012

Based on this landscape planning and house design by the House Building Research Institute, Dhaka, 58 houses in Bainapara were constructed and have been maintaining the solar system in the villages to provide electricity facilities.

FIG: 4.9 Disaster resilient Bainpara village, union Sutarkhali under the Dacope upazila of Khulna district, 2012

[Pictures taken by air. Shawly Samira]

4.2 Physical & Demographical development of TILDANGA union



Cyclone Sidr of November 2007 and Cyclone Aila on May 2009 attacked the union Tildanga under the Dacope upazila of Khulna district was affected most especially Botbotia village. But Botbotia village was less affected than Banipara. National, neighborhood What's more worldwide associations didn't approach to crisis assistance for the individuals for Botbotia village. None recognized something like their changeless answer for getting relieved starting with the long haul effect from claiming Sidr Also Aila.

FIG: 4.10 Map of the Study Area, **TILDANGA** (Dacope Upazila) [www.banglapedia.org]

Populaces of the village are 14,000 people. The greater part of the villagers are farmers. After these two cyclones houses, cultivable land, harvest, bank and other infrastructures were harmed and also suffocated under water for quite a while. They were likewise torment from claiming drinking water for that saltiness. Their sourball about drinking water might have been PSF (low maintenance) What's more also sprinkle water. The majority of the houses have golpata-fenced divider what's more a portion have tin-fenced with mud dividers. Floors need aid earthen aggravated and some need a block aggravated. Latrines need aid unhealthy and non-sealed. Houses are seriously harmed Eventually Tom's perusing Sidr Also Aila. Villagers are utilizing the accepted gathering framework to rain water. To blustery season individuals need aid utilizing blue plastic to Get those downpour water What's more mud pitcher (motka) may be utilized as a capacity supply.

FIG:4.11 Pictures Illustrates of the Botbotia village, 2012

4.3 Scenario of two unions

The findings of the field study are sequentially arranged as well as results from FGDs, individual interviews and different consultations based on data incorporated. Apart from that finding of different studies are included in appropriate parts of the report for better understanding and scope for comparison.

TABLE-4.1 PRESENT SCENARIO OF SUTARKHALI UNION AND TILDANGA UNION

	SUTARKHALI union	**TILDANGA union**
Village	Bainpara	Botbotia
Cyclone	AILA	SIDR and AILA
Population	38,000 people	14,000 families
Religion	Muslim	Hindu
Education	22%	45%
Economical condition	Villagers earned from different sources such as carpenter / fishery	Villagers are farmers
House condition	Construction with HH rising of existing one cluster through pilling. Materials of the houses are Ferro cement, brick and precast concert column.	The houses have golpata-fenced wall and some have tin-fenced with mud walls. Floors are earthen made and some have a brick made.
Cyclone shelter	Existing one cyclone shelter use as a school – in a bad situation Another shelter is construction – design with community participation.	One cyclone shelter use as a school – no maintenances Union Office High school
Effect component of cyclones	Houses Drinking water for salinity	Houses Drinking water for salinity
Source of water	03 nos pond 01 pond is delectated for PSF Rain water No tubewell	02 nos pond 01 pond is delectated for PSF, which is recently not working Rain water No tubewell

Collection system of drinking water	Rain Water Harvesting (RWH) for each family Disaster Resilient Pond Sand Filter (PSF) Also collect rain water in traditional ways. (plastic, pitcher, consumes some special fish for protection from bacteria)	Pond Sand Filter (PSF), recently not working Collect rain water in traditional ways. (plastic, pitcher, consumes some special fish for protection from bacteria)
Suffering for	Minimum level of drinking water	Maximum level of drinking water
Present level of salinity	Strongly present	Strongly present
Community participation	Strongly present	Absence
Emergency help	National, local and international organizations Shushilan, UNDP Center for Natural Resource Studies (CNRS)	Local people
	A new model Disaster Resilient village	Existing village develop by the villagers
		

Source: Field Observation

5 Chapter 05: PROPOSE A TECHNIQUE FOR THE COLLECTION OF DRINKING WATER

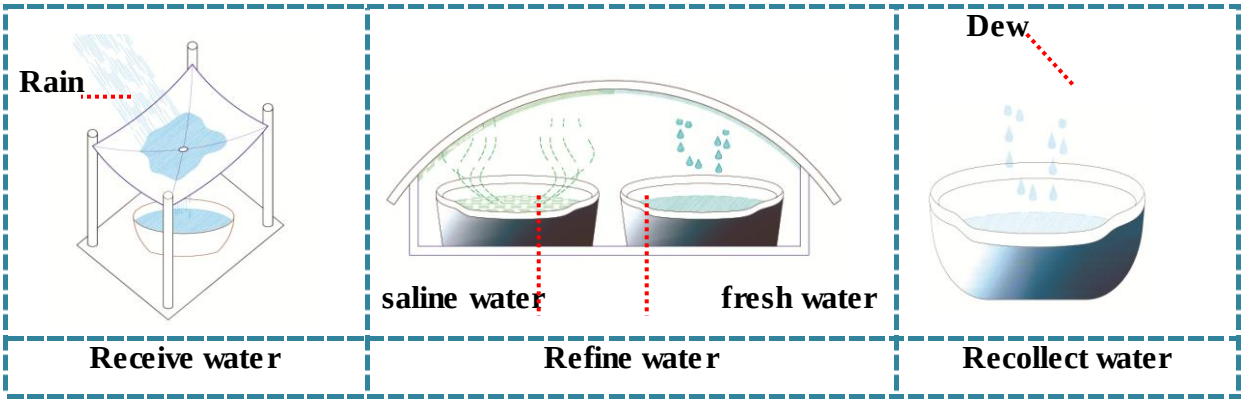
Water salinity is making the lives miserable in SUTARKHALI union and TILDHANGA union. Communities are suffering from a drinking water crisis. So that, the community has their traditional way of coping with this in a long time. Technological Intervention was also looked at. Therefore, introducing some technological contribution uses as tools. Here to suggest a device called **PANI** [Purified Aqua for Numerous individual] which is based on regular knowledge and throughout some technology, hopefully, these are helping for collecting drinking water throughout the year in the saline prone area.

Considering some aspect for PANI [Purified Aqua for Numerous individual]

- Target community [SUTARKHALI and TILDHANGA union]
- Accessibility
- Part of their daily life [maximum use]
- Durability and Duration
- Economical condition

The basic concept is maximum use of collection water throughout the year. The Main sources of this collection are rain, saline water, and dew. If we monitoring the yearly, graph, then it's clear these three sources are overlapping. So use these through the PANI for minimizing the drinking water crises

This device has three ways to collect water		
Rain	Saline water	Dew drop
The Concept is rain water collection system is very simple by using a surface with a slope so that water droplets to run down and into a collection of fresh water.	The Concept is a thin layer of water can absorb heat by producing vapors through the saline water. So transmitted solar energy [sun] through the glazing surface can allow accumulating into water droplets to run down and into a collection of fresh water.	The Concept is dew water collection system is using a surface with a slope so that dew droplets to run down and into a collection of fresh water.



There are short of the process for the individual collecting system. This can explain the basic process and how it related to each other.

Rain & Dew

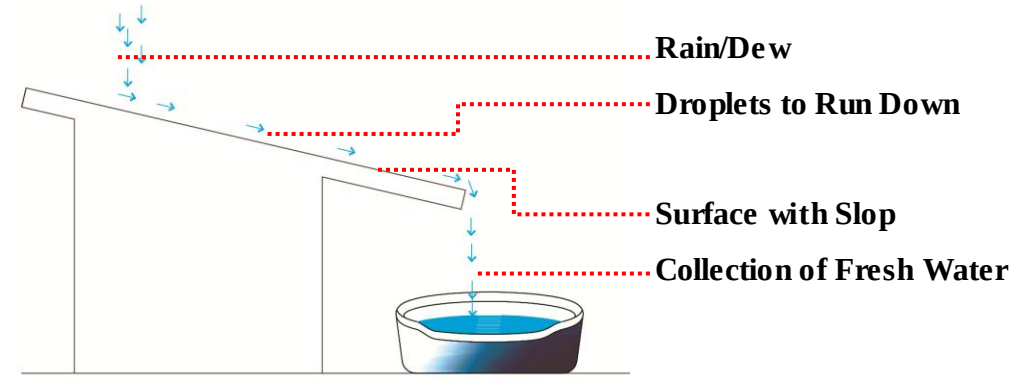


FIG: 5.1 Basic collection systems for rain and dew water

Saline Water

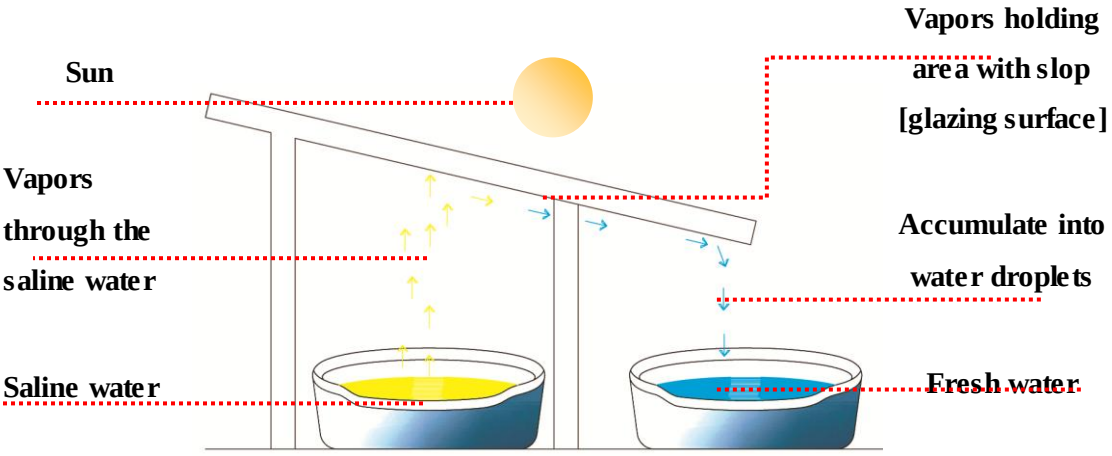


FIG: 5.2 Basic collection systems for saline water

In these two processes, there are some common components. If we combine these processes and make it as one unit. This unit can act in both ways. So that we can collect rain water or water from dew drops and transmitted saline water to fresh water. This unit/device called PANI [Purified Aqua for Numerous individual]

Basic component of PANI

- Natural energy[sun, rain and dew drop]
- Surface [catchment area , vapors holding area with slop]
- Containers for collection and storage
- Maintain slope to run down the water

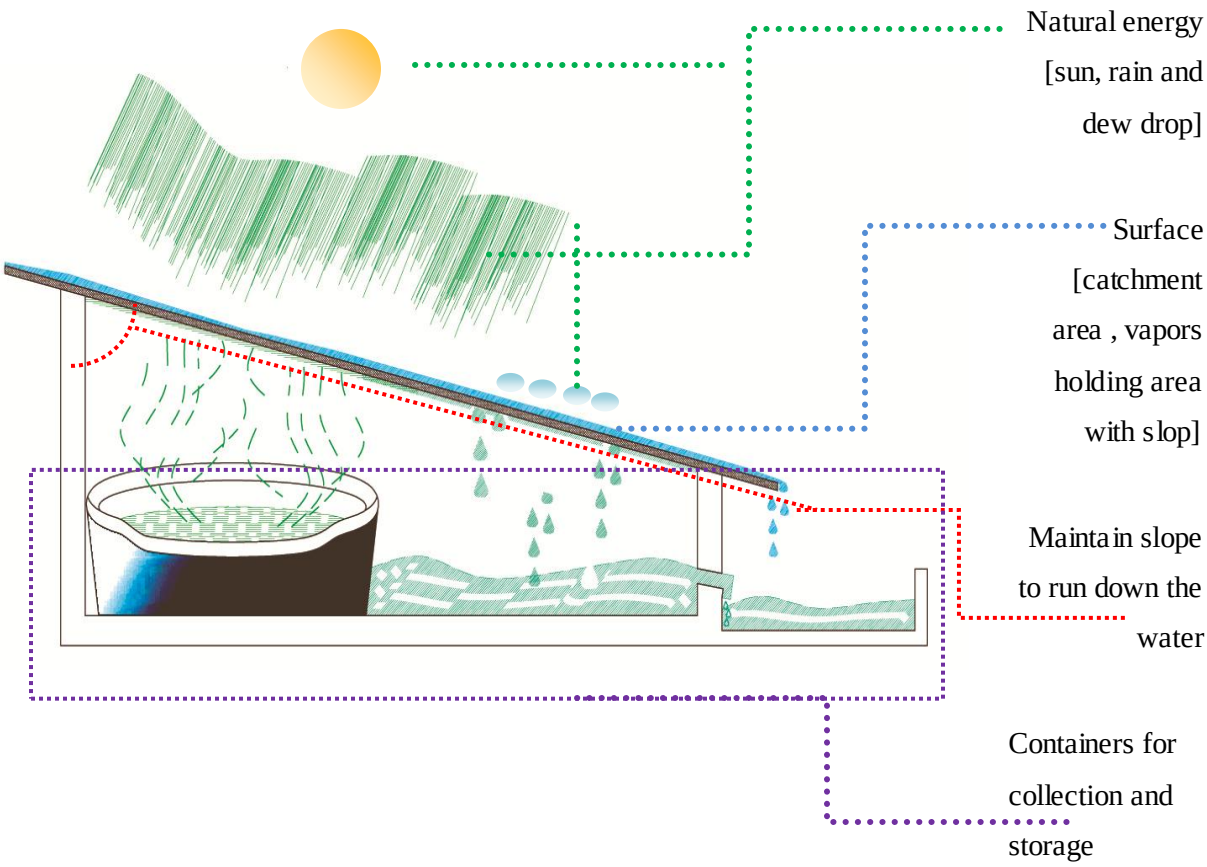


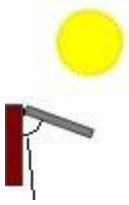
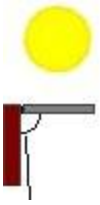
FIG: 5.3 Combination of basic collection systems

Amount of the component for PANI

Component	Amount	Work
Natural energy	Variable	Core part of the system activation
Surface	O1	• Transmitted solar energy • Catchment area • Vapors holding area with slop
Maintain slope	Related with surface	Accumulate into water droplets
Containers	03	• Saline water • Fresh water • Storage

Table-5.1 Optimum Tilt of Solar Angle by Month at Satkhira, Bangladesh

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
51°	59°	67°	75°	83°	90°	83°	75°	67°	59°	51°	44°

Winter	Spring/Autumn	Summer
		
44° angle	67° angle	90° angle

Source:http://solarelectricityhandbook.com/solar-angle-calculator.html

5.1 Development Phases

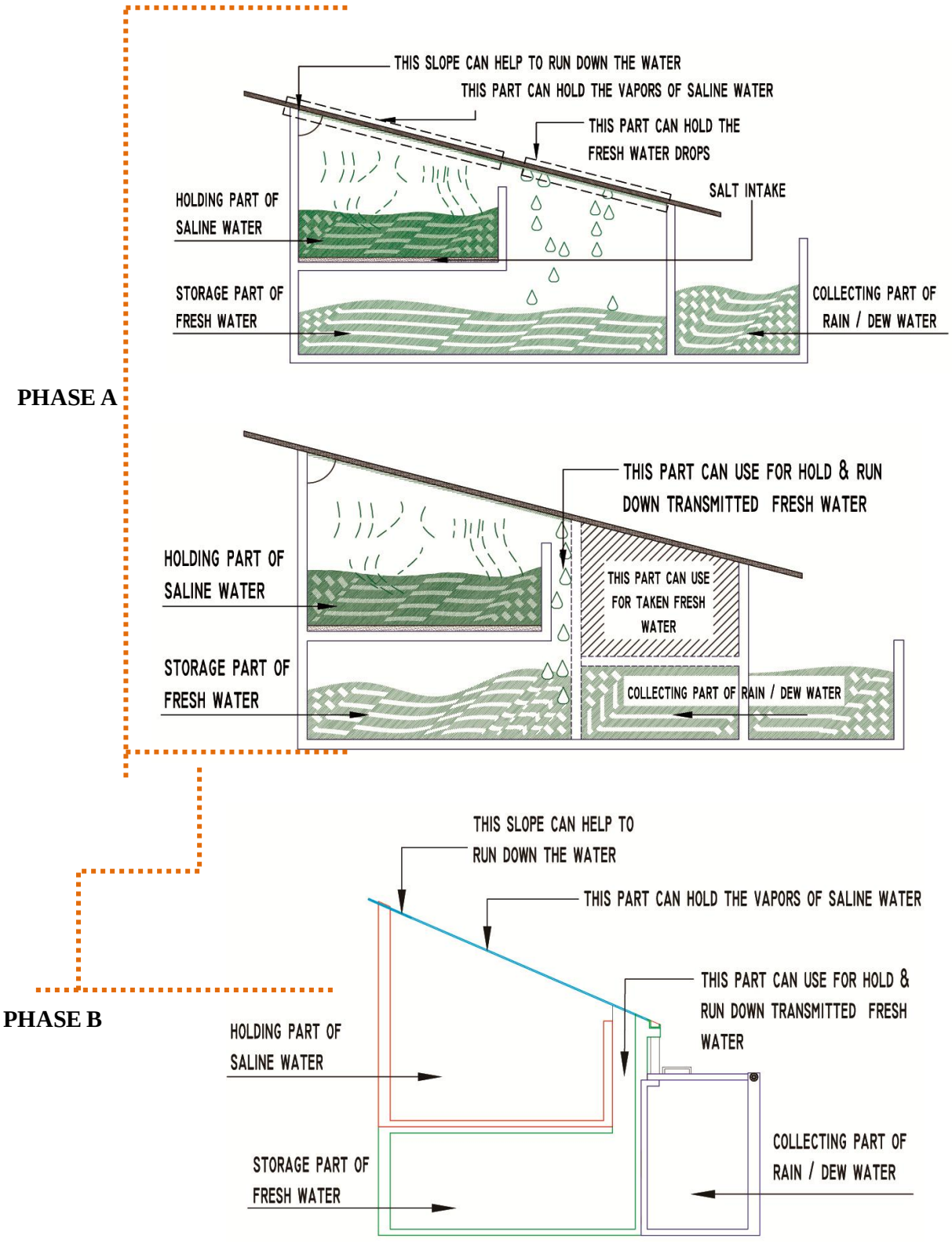


FIG:5.4 Initial phases

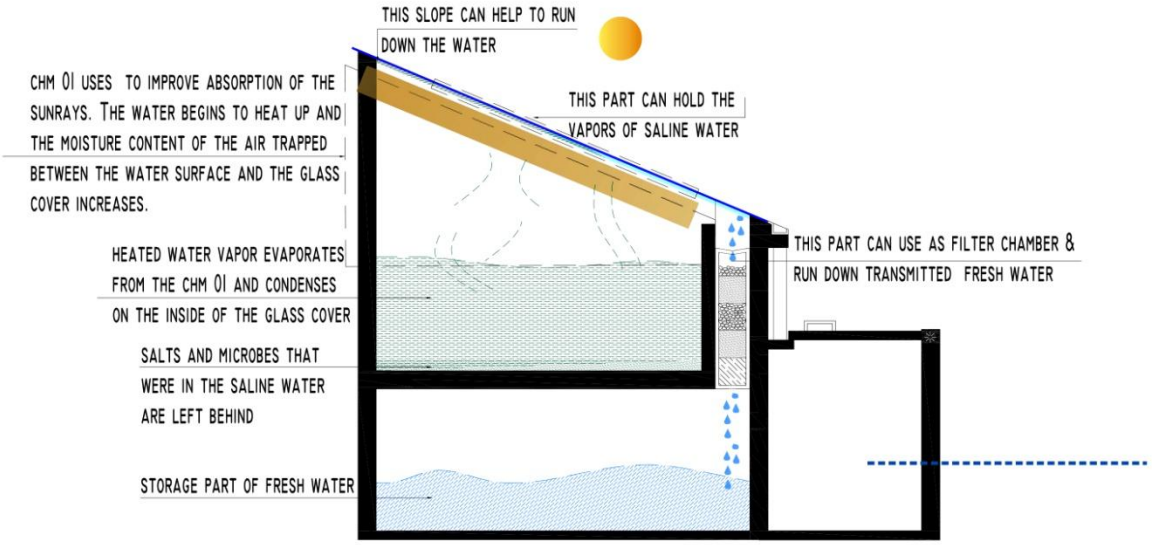


FIG:5.5 Eventual phase 01

In this phase, filter part is also attached to the device. Traditional propose of filtration is used.

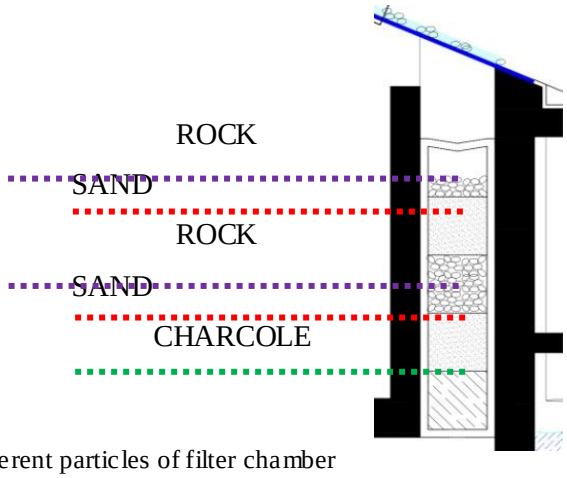


FIG:5.6 Different particles of filter chamber

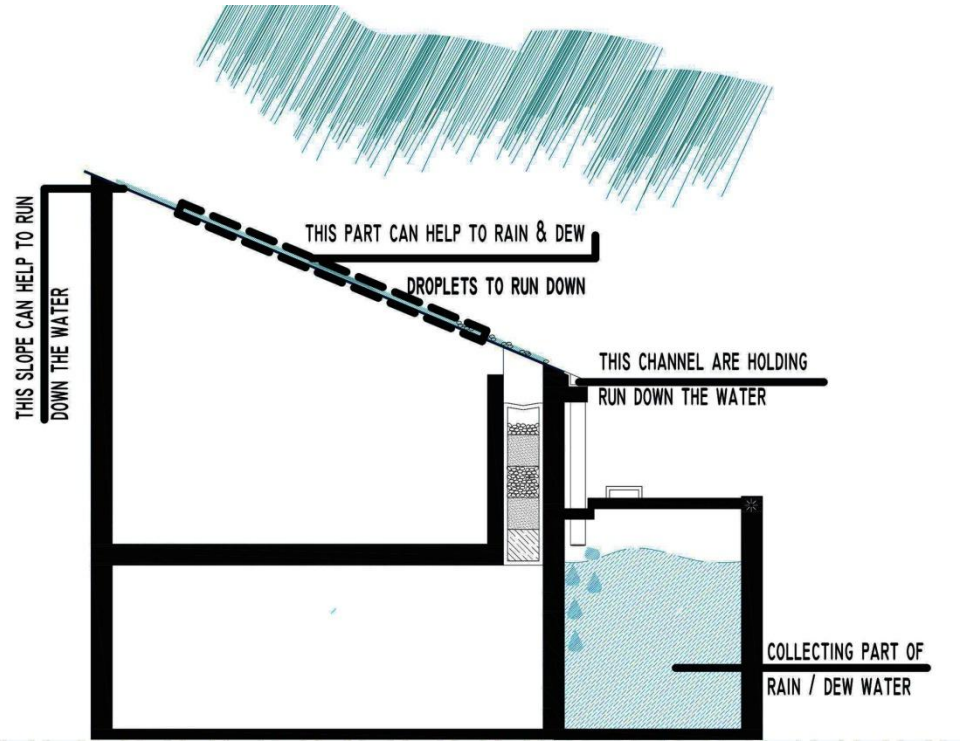


FIG:5.7 Eventual phase 02

The process of rain water and the dew water collection system is very simple by using a surface with slop, so that water droplets to run down and into a collection of fresh water. Also in the saline water, we need two chambers and one slope surface. One chamber is the use of a thin layer of saline water can absorb heat by produces vapors through the saline water. So that transmitted solar energy through the slope surface can allow accumulated into water droplets to run down into a collection of fresh water. PANI is kind of a process, which can help for collecting drinking water throughout the year. Even in disaster period, it will be moving from one place to another.

- Chamber 01 [Carrier]
- Chamber 02 [Filter]
- Chamber 03 [Storage]
- Chamber 04 [Collection]
- Glass Surface [Maintain slope for run down the water]
- Channel

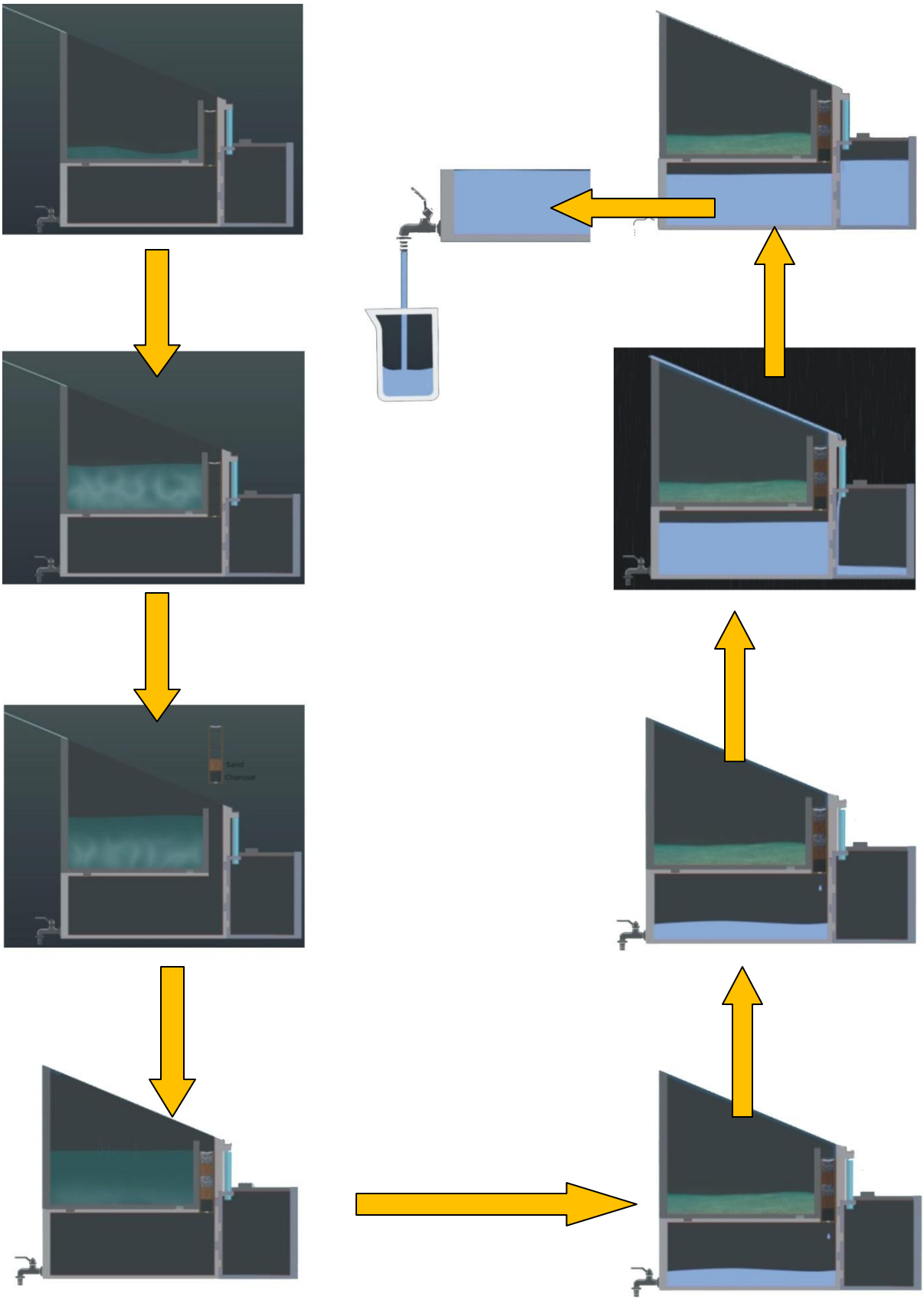
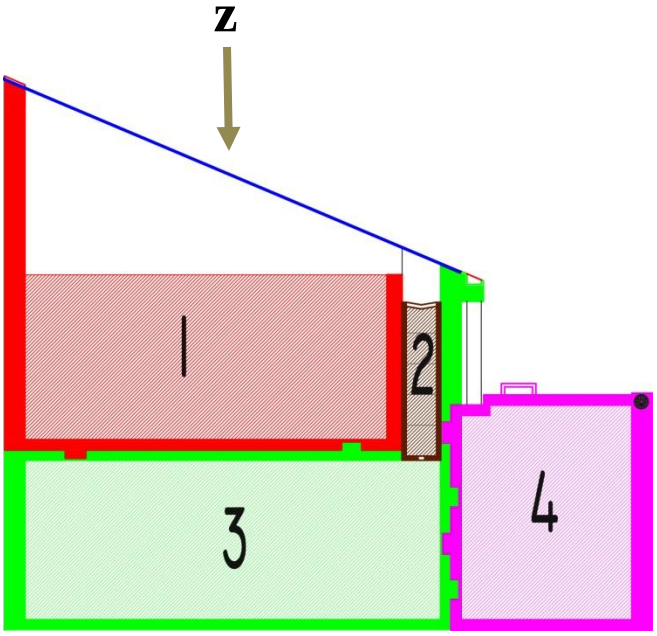


FIG:5.8 Working process of PANI

Estimating storage requirements



This unit/device may design with the different part. So there are 4 types of area are included here. First, calculate the holding area of saline water; so that it can define the area of collecting refine water. Because Saline water area ≤ refine the water area. The collecting area can vary.

FIG:5.9 Different part of PANI

If we calculated the approximately size are

	Usable Container size	Consumption water [apx]
CHM 1	[1'-6" X 1'-4" X 0'-8"] ~ 1.18 cft	5 liter
CHM 2	[1'-8" X 1'-4" X 0'-8"] ~ 1.2 cft	5 liter
CHM 3	[1'-0" X 1'-4" X 0'-9"] ~ 1.18 cft	5 liter

This device is designed for 5 liters of water for receiving, refine and recollect. Also, there are some parameters for the angle of "Z".

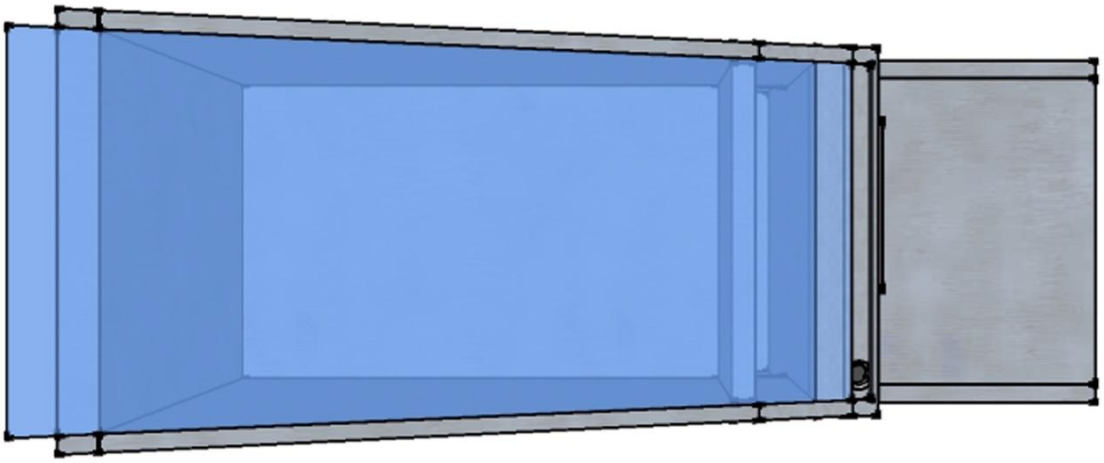


FIG: 5.10 Top plan of proposed device PANI

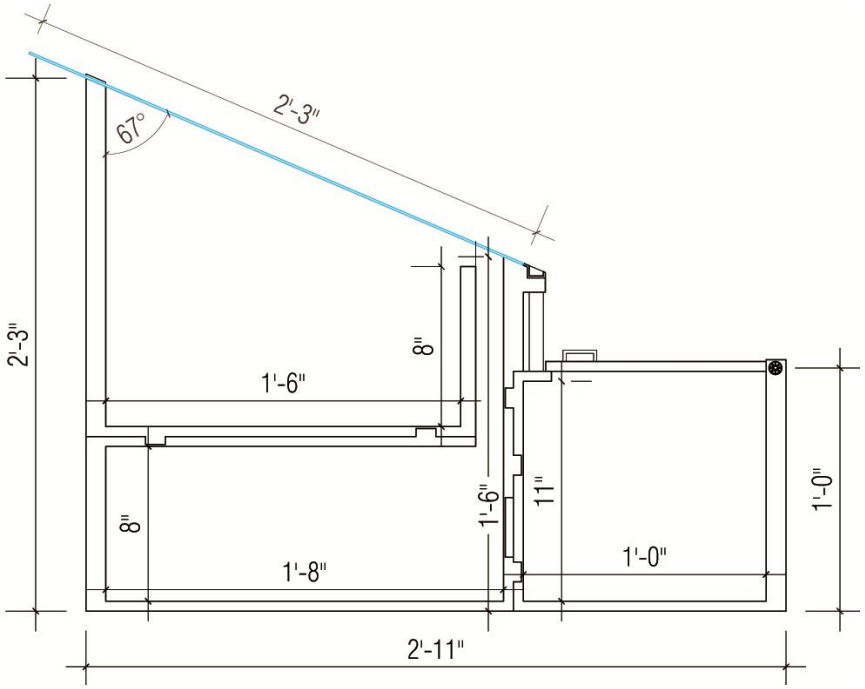


FIG: 5.11 Sectional drawing of proposed device PANI

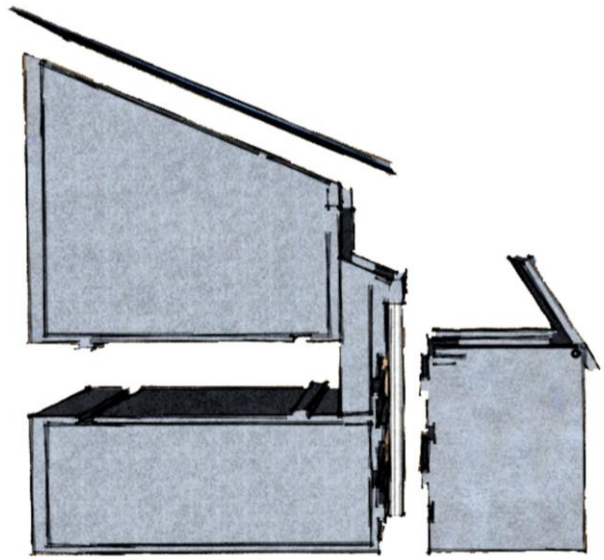


FIG:5.12 Different part and locking system of proposed device PANI

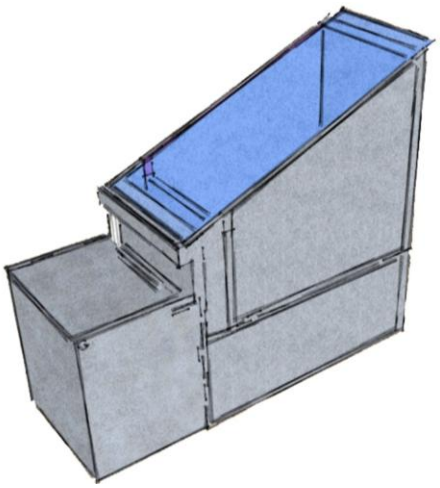


FIG: 5.13 Proposed Devices PANI

Design of Device:

The base of PANI of dimension [2'-11" X 1'-4" X 2'-3"] and Angle Θ = 67°. This also contains the same box of the channel is fixed such that the water slipping on the surface of the glass will fall in this channel under the effect of gravity.

FIG:5.14 Working Model of PANI

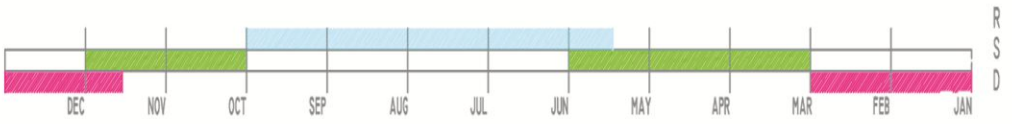
5.2 Details of Different Parts of PANI:

Different Parts of PANI is essential that it must absorb solar energy. Hence it is necessary that the materials have high absorbed or very less reflectivity and very less transitivity.

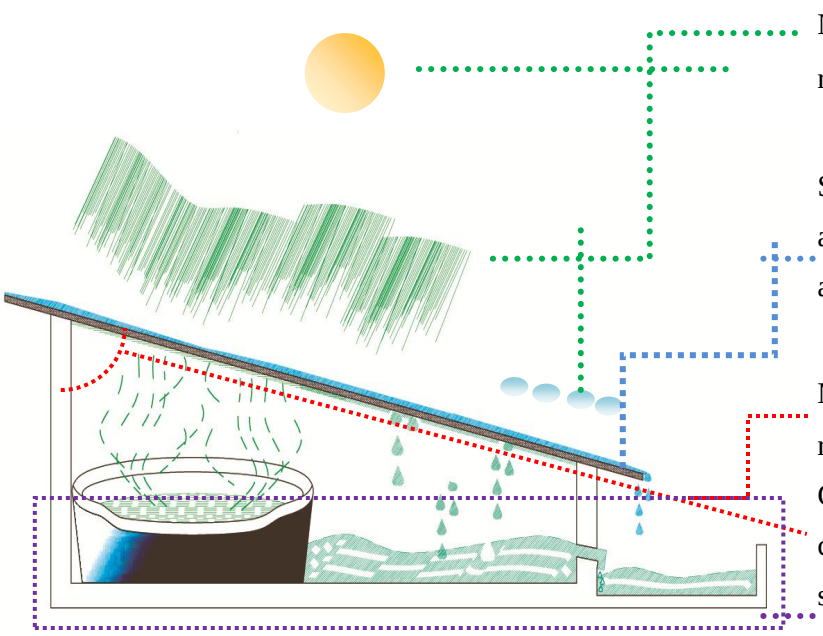
Table-5.2 Relation between the materials, material aspect and average cost

No	Parts Of RCSW	Materials Aspect	Material	Average Cost
1	Top cover [Z]	1. Transmitted solar radiation 2. Non absorbent of water 3. Clean and smooth surface.	Glass [8 mm / 10 mm]	120 sft
2	Holding part of saline water [A]	Low value of thermal conductivity	1. Plastic wood	3500/-
	Storage part of transmitted fresh water [B]		2. S.S	16000/-
	Collecting part of rain/ dew water [C]		3. RPF (reinforced plastic)	
			4. Ferro Cement	
			5. M.S with heat paint	3000/-

Table-5.3 Parameters of proposed devices PANI

			
Collection stage	**Rain water**	**Saline water**	**Dew drop**
Duration of day	**7-8/9 hr**	**9-10 hr**	**6-7 hr**
Rainfall [precipitation]	**≥ 145 mm**		
Temperature		**≥ 31°C [87° F]**	
Solar Angle		**Winter** 44° angle **Spring/ Autumn** 67° angle **Summer** 90° angle	
Basic Concept	The Concept is rain water collection system is very simple by using a surface with a slope so that water droplets to run down and into a collection of fresh water.	The Concept is a thin layer of water can absorb heat by producing vapors through the saline water. So transmitted solar energy [sun] through the glazing surface can allow accumulating into water droplets to run down and into a collection of fresh water.	The Concept is dew water collection system is using a surface with a slope so that dew droplets to run down and into a collection of fresh water.
	Receive water	**Refine water**	**Recollect water**

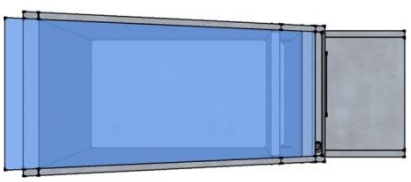
Basic component of RCSW

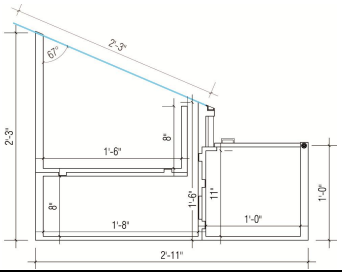


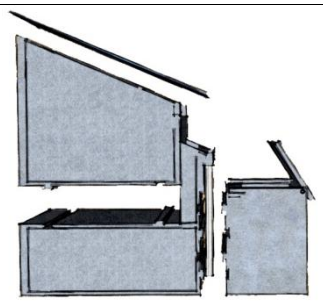
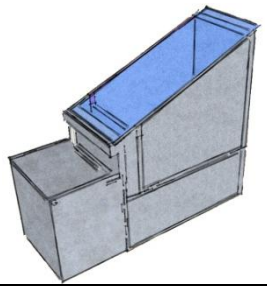
Specification

Natural energy	Variable	Core part of the system activation
Surface	O1	• Transmitted solar energy • catchment area • vapors holding area with slop
Maintain slope	Related with surface	Accumulate into water droplets
Containers	03	• saline water • fresh water • storage

Drawings





<table>
<tr><td>3d views</td><td>   </td></tr>
<tr><td>Cost Estimation</td><td>
<table>
<tr><th>Parts Of RCSW</th><th>Materials Aspect</th><th>Material</th><th>Average Cost</th></tr>
<tr><td>Top cover [Z]</td><td>1. Transmitted solar radiation
2. Non absorbent of water
3. Clean and smooth surface.</td><td>Glass [8 mm / 10 mm]</td><td>120 sft</td></tr>
<tr><td>Holding part of saline water [A]</td><td rowspan="3">Low value of thermal conductivity</td><td rowspan="3">2. S.S 16000/-</td><td></td></tr>
<tr><td>Storage part of transmitting fresh water [B]</td><td></td></tr>
<tr><td>Collecting part of rain/ dew water [C]</td><td></td></tr>
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<tr><td>Working Model</td><td>    </td></tr>
</table>

6 CHAPTER 06: CONCLUSION

We cannot overlook the fact that the proximity of disasters, especially of the cyclone is really high in coastal areas. The source of safe drinking water is limited in coastal areas of Bangladesh, due to intolerably high salinity. Bangladesh has around 160 millions of people is highly vulnerable to climate change and sea level rise. In the last 10 years, Cyclone Sidr'2007 and Cyclone Aila'2009 made a huge disastrous change in those areas, particularly people are terribly suffering through scarcity of drinking water. According to the previous research, 40% of drinking water ponds of the Polder areas and 100% of affected areas contaminated with saline water. Approximately 10% of the ponds have been de-watered and 90% of the tube wells were submerged. Cyclone destroys a considerable number of village houses, leading to an increased risk, housing problems and financial burden of reconstructing the houses. It has also been observed that both natural and man-made changes can alter the lock off access to safe drinking water are a significant barrier to improving the health and wellbeing and reducing poverty in the coastal communities.

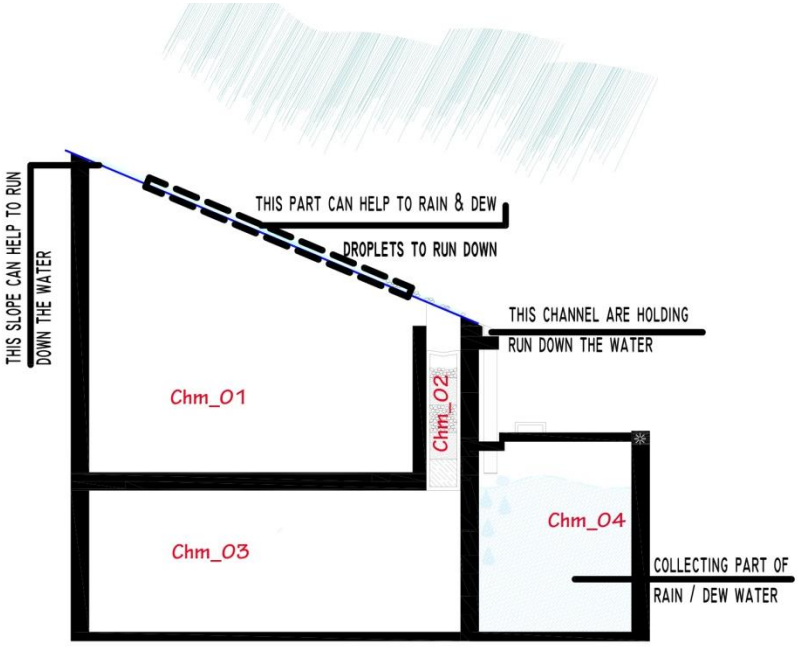
In this paper, a broad study has been conducted in a few communities which are Decope upazilla of Khulna District, two villages named Bainpara from Sutarkhali union and Botbotia from Tildanga union, which was badly affected by Cyclone SIDR [November 2007] and AILA [May 2009]. After the field survey and affected area, another visit in Khulna has been done, which was one of the important southern regions of Bangladesh, it was comprehensible that water salinity is making the lives miserable. Groups are experiencing a drinking water emergency. However, people group have their conventional method for adapting to this in quite a while. The innovative methodology was additionally taken a gander at. The wide line target of this research is combining the traditional knowledge of collecting drinking water with the technology strategy to determine and identify potential alternatives available to establish drinking water by modifying the saline water of the affected community of southern Bangladesh.So the question is, What is the technique of collecting drinking water for this salinity ingression, which is also economically affordable, easy accessibility, maximum use, portability and durability for the affected community of southern Bangladesh?

During the field observation, total 11 FGDs was conducted to better understand the community's idea with culture and find out appropriate water harvesting systems with the household. Also, the total of 15 EIs (Expert Interview) was conducted, of which two were

held at the national level, three at sub district (Upazila) level, and ten at community (local) level. Social mapping is revealed certain information like the settlement pattern, types of the drinking water collection method, total no of household, source of income of the households, areas of important places like schools and temples, the village path, cultivated areas, safe areas evacuate during the cyclone etc. The Livelihood examination apparatus was understood the critical data with respect to the social structure and power circulation of those specific areas. In addition, it recognized the effect of disasters on the livelihoods of the community.

After the field survey and affected area, it was comprehensible that water salinity is making the lives miserable. The community was facing a horrible situation of lacking drinking water. Without any doubt, it will increase day by day. Physical consequences are most people suffering from one or more saline water-related disease, skin diseases, health effects, including increased hypertension rates. Large numbers of pregnant women in the coastal areas are being diagnosed with pre-eclampsia, eclampsia, and hypertension. After having the drinking water scarcity, peoples have to collect drinking water from distant sources. Mostly Women are required to perform this duty. This may sometimes cause social consequences. The main economic consequences are if some family cannot afford to collect water due to sickness they have to buy water from water vendors at Taka 10 per pitcher, which spend 300 taka per month. [When monthly income is maybe 500 tk – 1500 tk]. Therefore, they have no choice but to use saline water for drinking purposes. Also, the salinity related disease treatment is expensive. These observations emphasize the need for a dedicated national effort to provide local knowledge with technology-based information towards the drinking water collection system. However, the concept of PANI [Purified Aqua for Numerous individual] should also address the following issues to minimize the lacking of water and maximizing collecting of drinking water throughout the year at its implementation processes. The Focus of this device is a sustainable solution for safe drinking water. This technique of collecting drinking water is also minimizing salinity ingression, which is also economically affordable, easy accessibility, maximum use, portability and durability for the affected community of southern Bangladesh.

The basic concept is maximum use of collection water throughout the year. The main sources of this collection are rain, saline water, and dew. If we monitoring the yearly graph, then it's clear these three sources are overlapping. So use these through the PAIN for minimizing the drinking water crises. The process of rain water and the dew water collection system is very simple by using a surface with slop, so that water droplets to run down and into a collection of fresh water. Also in the saline water, we need two chambers and one slope surface. One chamber is the use of a thin layer of saline water can absorb heat by produces vapors through the saline water. So that transmitted solar energy through the slope surface can allow accumulated into water droplets to run down into a collection of fresh water. PANI is kind of a process, which can help for collecting drinking water throughout the year. Even in disaster period, it will be moving from one place to another. The components are Chamber 01 [Carrier], Chamber 02 [Filter], Chamber 03 [Storage], Chamber 04 [Collection], Glass Surface [Maintain slope for run down the water], Channel



In addition, the possibilities of the water collecting framework from the proposed device will be extremely useful to gather drinking water by cleaning saline water of all seasons and furthermore from rain water and with dew drops also. Moreover, we cannot all of a sudden superintending the existing climate situation and its impact in terms of increased salinity in the water resources of the southern coastal areas of Bangladesh. In such situations, where the source of safe drinking water is limited in coastal areas, this proposed solution PANI can definitely become a grip for local people to arrange drinking water in their home by themselves.

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ANNEX A – QUESTIONNAIRE

Questionnaire for Focus Group Discussion

As a part of my thesis for Postgraduate Programs in Disaster Management, BRAC University. This focus group discussion, conducting to collect information on particular topics. The dissertation topic is " Propose a technique of drinking water collection for the cyclone affected community of southern Bangladesh ". Your participation in this study is completely voluntary. However, if you feel uncomfortable answering any questions, you can withdraw at any point. It is very important for us to learn your opinions.

Thank you!
Afsana latif

Name of respondent:	**M / F**
Village:	Union:
Upazila :	Khulna :
Number of family members:	Education:
Income source:	
What is the main hazard of your area? _	
What about its strength? _	
What percentage of your area was impacted? _	
What are the sources of the drinking water? _	
Is there any water collection source of government of Bangladesh? _	
What is the traditional method of collecting drinking water? _	
What is the problem you face for the salinity? _	
Are you Suffering for Present level of salinity? _	
How you purify the saline water? _	
What are the sources of the drinking water during cyclone? _	
Community participation? _	
What actions are taken after cyclone? _	
Please draw on your own personal experience or observations on lacking of drinking water	