PROJECT COMPLETION REPORT

DEVELOPMENT & IMPLEMENTATION OF CLIMATE RESILIENT WATER SAFETY PLAN IN VULNERABLE RURAL COMMUNITIES OF COASTAL AREAS

15 July-15 December 2017

World Health Organization

PRACTICAL ACTION
Technology challenging poverty

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ACRONYMS

AIRP	Arsenic Iron Removal Plant
DPHE	Department of Public Health and Engineering
DHTW	Deep Tube well
FGD	Focus Group Discussion
HH	House Hold
KII	Key Informant Interview
LGIs	Local Government Institutions
PSF	Pond Sand Filter
RWHS	Rain Water Harvesting System
SI	Sanitary Inspection
SHTW	Shallow Tube Well
UP	Union Parishad
WSP	Water Safety Plan
RW	Ring Well

ACKNOWLEDGEMENT

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Community	Community dwellers, Religious leaders

1. EXECUTIVE SUMMARY

The development and implementation of climate resilient WSP project started from 15 July to 15 December 2017 by Practical Action with the technical and financial support from WHO, in eight unions of three upazilas under three districts in South East and South West coastal locations of Bangladesh. The project was carried out in saline prone areas with a view to develop and implement a Climate Resilient Water Safety Plan in the selected rural communities of coastal area. This report provides key information, insights, evidences, learning and findings that were captured and documented throughout the project period by applying different methods, approaches, tools and techniques i.e. literature review, KAP baseline, demonstration, end line survey, observations, consultations etc. The key information and findings are based on the climatic and environmental effects, people's perception, drinking water value chain (Source to use), hygiene behaviour, sanitary inspection, safe water and health and water quality.

The climatic effect is gradually increasing on environment and extreme weather events, especially seasonal variations, temperature change and the trend of rainfall, are occurring more frequently. This has led to the deterioration of the quality, accessibility, availability, and functionality of drinking water facilities. Almost all water points are vulnerable and robust alternative technology is needed to eventually make the communities climate resilient in terms of WSP.

Most of the present technology in terms of water point is vulnerable due to climate variability and extreme weather events. With changes in climate conditions, frequency of natural disasters has also increased leading to damage of the present water source, e.g. inundation and damage of water points. Thus, to overcome such challenges present water options need to be adapted with keeping in mind changes in future climatic conditions, like, raising the platform and anchoring the tube-well to it. Hence, focus need to be given in building the knowledge and awareness of the communities about the effect and adaptation of climate change in the WSP.

The correlation between microbial water quality and Sanitary Inspection (SI) risk score is critically important. Analyses of SI indicates that the microbial water quality varies with change of practices of water safety plan by the users. The communities are not making decisions based on how the climate has changed in the last few decades and how it can change even more in the future. Rather most of the people are installing new technologies or changing the life style based on recent weather changes rather than long term climatic changes. The existing community groups, health workers, religious leaders, DPHE tube well mechanics and CBOs can play an important role for the sustainable promotion and scaling up of climate resilient WSP through sensitisation, capacity building and financial safety-net.

Different types of events including awareness raising, capacity building, demonstration, pre and post interventions survey, proper monitoring and follow up, networking and linkage with relevant stakeholders were undertaken to achieve the objectives of this assignment.

There were some visible changes observed as compared to the baseline information. 62% of the respondents observed changes in climatic parameters. As a result, frequent disasters were happening and 34% of the respondents suffered in terms of collecting drinking water from distant sources.

More than 67% of respondents knew about the WSP which was only 18% at baseline. The trend of incidences of the water borne diseases over time also increased from 76% to 96%. Most dominating one is diarrhea replied by 96% of the people which was 75% during baseline. This can be due to the high prevalence of water born disease during dry season.

Response for reducing microbial contamination by WSP reduced from 78% to 53%; for good health increased from 50% to 66% and for reducing diseases increased from 27% to 73% respondents. Safe water use contributing to the good health changed from 47% to 73%, sanitation 20% to 42% and hand washing from 37% to 55%. Having hand washing device increased from 48% to 67%; washing hands after defecation increased from 59% to 82% and washing.

Particularly SHTW, DHTW, PSF, Ring well and protected pond resulted low risk level compared to others with baseline. In all cases, the quality of water at storage found better compared to baseline. There is a good correlation between E. Coli and SI risk score as compared to the baseline data which will guide users, researcher and practitioners to develop and implement climate resilient WSP.

The responses of community and other stakeholders were found very positive and effective towards the wider promotion of climate resilient WSP. However, conscious efforts should be put for introducing and promoting robust alternative technology. Demonstration of climate resilient WSP is important and effective for creating awareness, capacity and skill on operation and maintenance of water facilities.

Allocation of fund should be considered by the union parishad for operation and maintenance, upgrading of existing infrastructures into climate resilient ones and installation of few climate resilient infrastructures to ensure serving the people for long run, withstanding climate change impacts.

1. BACKGROUND

Bangladesh is a country vulnerable to climate variability and extreme weather events considering its geography and topography. The impact of climate variability has deteriorated both the drinking water quality and its availability. We also see millions of people suffering directly or indirectly from water and vector-borne diseases such as diarrhoea, malaria, and dengue. Climatic variability further exacerbates the prevalence of these diseases. Extreme weather events such as cyclone, storm surges, tidal surges and saline intrusion are also creating negative environmental impacts. Sea level rise and prolonged inundation in the coastal regions have led to rise in the salinity levels as well as contamination of solid waste and faecal sludge in the water. All these factors have reduced the quality, accessibility, availability and functionality of water. In addition, different socio-economic factors like poverty, lack of education and density of population is also worsening the water quality.

As per the MICS report 2012-2013, the survey result indicated that 97.9% of the households nationally have access to improved water sources of which most of the people in rural areas are using tube well for drinking and cooking purposes. In addition, ring/ dug wells, PSF, rain water harvesting systems, purification filters and other alternative and mitigation technologies are used depending on the geographical and geo-hydrological context. In some cases, small scale community based piped water supply is also found in rural areas. However, it is seen that due to extreme weather and climatic variability many of these present technologies or water sources will cease to function as a safe source of water supply in the future. Thus steps need to be taken to either introduce climate resilient adaptation into the existing water sources or switch to alternative climate resilient technologies.

Considering these climate change impacts on water facilities, context specific comprehensive climate resilient WSP has been developed and implemented with a view to create more sense among rural community, users, caretakers, mechanics, development practitioners, LGIs, CBOs, UDMC, WatSan committee, water supply staff and others. Hazard types, their sources, risks rating, control measures, monitoring system, supporting programme and plan of improvement, emergency management plan has been considered to develop a climate resilient WSP.

The “Development and Implementation of Climate Resilient Water Safety Plan in Vulnerable Rural Communities of Coastal Areas” project was launched with the main objective to develop and implement a climate resilient water safety plan in the eight rural communities of coastal areas. The assignment achieved this through undertaking a systematic identification of climatic and environmental hazard related with different water points in coastal areas and develop a climate resilient water safety plan. Implementation of this WSP was done through awareness building and capacity building of key stakeholders. Their progress, result, impacts, challenges and lesson learned are explained in the below sections.

2. PROJECT SNAPSHOT

a. Context

With the increasing vulnerability faced especially by the coastal regions of Bangladesh, the project aimed to change the Water Safety Plan in context to climate change. The project focused in three districts of Bangladesh (Pirojpur, Cox’s Bazar and Khulna) with high salinity levels. Due to the climatic impacts, the water quality and availability has been deteriorating considerably in these areas. Thus the project aimed to promote WSP against the deteriorating conditions of the water options and bring about an order to systematically assess and manage risks related to safe water.

b. Objective

The overall objective of the project is to develop and implement a Climate Resilient Water Safety Plan in the selected rural communities of coastal area.

Specific objectives:

- To know the impacts of climate variability and extreme weather events on the sources of drinking water facilities.
- To know the climate adaptive measures or solutions that the communities have been taking.
- To know the changes of hygiene behavioural practice and people's perception in comparison with baseline and end line study.
- To analyse the quality of drinking water at sampled source and storage (10% of total surveyed households) through testing at field and lab to determine changes in practices.

c. Working Locations

The following unions were selected due to the climatic variability and the extreme weather evets faced in these regions. Cyclone, storm surges, tidal surges, saline intrusion and sea level rise are very prominent in these areas.

Sl.	District	Upazila	Union	HH	Population
1	Pirojpur	Mothbaria	Gulshakhali	5170	21096
2			Shapleza	6670	38020
3	Cox's Bazar	Sadar	Bharuakhali	4280	30101
4			Chaufaldandi	5811	33615
5			Islampur	3815	33000
6			Khurushkul	7966	67000
7	Khulna	Dacop	Dacop sadar	1820	12131
8			Kamarkhola	4056	15292
Total				**39,588**	**250,255**

d. Project Period

The "Development and Implementation of Climate Resilient Water Safety Plan In Vulnerable Rural Communities of Coastal Areas" project was launched from 15 July, 2017 to 15 December, 2017 in 8 unions of 3 upazilas under Cox's Bazar, Pirojpur and Khulna district to develop and implement a Climate Resilient Water Safety Plan in the selected rural communities of coastal area to improve the situation of water safety by motivating, capacity building, demonstrating, monitoring and follow up, and introducing user friendly communication materials.

3. METHODOLOGY AND APPROACH

The project was implemented in close coordination with DPHE district, sub district offices, local staff, health department and Union Parishads, education department and weather department. Household survey, FGD, KII and consultation workshop were conducted with the project stakeholders to collect information regarding climate variability and extreme weather events that create impacts on water quality, availability, accessibility and functionality of the safe water sources. Community mobilization, effective communication tools development and use of materials, mobile based online monitoring, local capacity building, networking and linkage with the stakeholders were established for a climate resilient WSP.

A partnership agreement was signed with two local NGOs named Jago Nari and Mukti Cox's Bazar to effectively delivery the project at field level through community mobilization, local facilitation, consultation, coordination and cooperation with both government and non-government stakeholders.

A comprehensive baseline and end line survey was conducted to understand the impacts of climate variability and extreme weather events on each type of water technologies in each project area. People's perception regarding the knowledge and practice of water safety from source to consumption, climate change and environmental hazard and its effect on water supply and safety, impact on health and Water Quality (bacteriological, chemical and physical) situation at source and household level were also looked at.

HH Survey, SI, FGD, KII, Case Study and Water Quality Testing were the primary methods used in conducting both the surveys. A multi-stage cluster sampling technique was applied for conducting the HH Survey as well as for the Sanitation Inspection with a sample size of 810 HHs. The project also introduced digital tools (Mobile based) for monitoring and data collection of the surveys.

4. MAJOR INTERVENTIONS, OUTPUTS AND OUTCOMES

One of the major steps taken under this project was to conduct an analysis of the climatic and environmental hazard and develop a technology specific hazard matrix. Hazard analysis report was developed on the basis of the findings captured from the sanitary inspection, KAP baseline study and water quality test in the context of cyclone and saline prone areas (Ref. Hazard analysis with WSP report). Emphasis was given to hazards, hazardous events or source of hazards, risk rating with its severity (Low, medium, high and very high) and its consequences, control measures, operational monitoring plan and improvement plan for each type of technologies that has been clearly identified and explained into the report. The objective of the analysis was to,

- To identify and analyse all potential biological, chemical and physical hazards associated with each steps of the water supply system (Source to consumption) in different geographical locations that affect the water security and safety,
- To assess risk and its prioritization with possible control measures, improvement opportunities and other activities for utilities/communities, and
- To develop an improvement and monitoring plan for each type of water facility.

Initially, comparison of monthly normal rainfall of Bangladesh based on 1981 – 2010 and 1971-2000 respectively, was done which showed that the average rainfall increased highest in July compared to September and October. The rainfall pattern of the remaining months was seen to be decreasing.

The consequences due to the temperature and rainfall variation, reduced freshwater flows combined with increased sea levels have led to the results being anticipated like increased salinization of surface and ground waters, increased inundation of coastal freshwater wetlands and lowlands, and reduced quality of water supply.

Due to the lack of accessibility and availability of safe water sources, people somewhere are using water direct from pond for their drinking purposes. Out of that, very few people are using water after alum coagulation as treatment in their HH storage. Based on all these analyses along with the site visit, water quality test, sanitary inspection, consultation, desk analysis and literature review was done to derive a comprehensive technology specific hazard matrix, which is shown in Table 1.

Table 1: Technology Specific Hazard Matrix

<table>
<tr><th>Water option</th><th>Climatic and Environmental Hazards</th><th>Impact on water option</th><th>Remedy through WSP</th><th>How to implement</th></tr>
<tr><td>TW (both SHTW and DHTW)</td><td>• Cyclone
• Tidal surges
• Sea Level rises
• Erotic rainfall</td><td>• Damage of infrastructure
• Contaminated by salinity, pathogen
• Other contaminants (TDS)</td><td>• Repair platform and raise base of Tube well considering highest peak of tidal surges
• Use bleaching powder, alum
• Mix with low saline water (Safe)
• Installation of alternative water source i.e. RWHS, PSF, RO</td><td rowspan="3">• By Community and Union parishad through consultation, meeting and planning on operation and maintenance and climate adaptive response

• By Policy makers, decision makers; technocrats and sectors actors through sensitization about the resource requirements for mainstreaming climate resilient WSP, incentives for promoting alternative water options and R&D – Robust climatic factors

• By accountable institutions (DPHE, LGIs) and communities through enhancing communication on water quality issues</td></tr>
<tr><td>PSF and Pond</td><td>• Cyclone
• Tidal surges
• Sea Level rises
• Erratic rainfall
• Increased Temperature</td><td>• Contaminated by salinity, pathogen and TDS
• Deteriorated water quality
• Algal growth and increased evaporation rate due to increase temperature
• Increased pressure on filter media and frequency of cleaning</td><td>• Raise embankment
• Re-excavate pond
• Protect pond from domestic works i.e. washing, bathing
• Regular back washing of filter media
• Use bleaching powder, alum for pond water</td></tr>
<tr><td>RWH</td><td>• Erratic rainfall
• Cyclone with Tidal surges</td><td>• Deteriorated water quality
• Damage infrastructure</td><td>• Increase the capacity of the reservoir
• Use bleaching powder and alum
• Integrate with other safe water sources like PSF, TW, RO
• Repair and raise the basement of the reservoir</td></tr>
</table>

Based on the findings of this analysis, control measures, operational monitoring and corrective action for general water sources were developed. Improvement plan for social mobilization and awareness raising among community on climate resilient WSP were sought out as the most effective means to implement a climate resilient Water Safety Plan.

The project focused around the following major intervention areas through which it aimed to achieve the set out objectives. Various awareness campaigns, trainings and demonstrations were carried out through which changes in hygiene behavioural practice and people's perception, practice of quality drinking water, resilience to climate variability in terms of drinking water facilities were observed.

Details of the activities are given below.

a. Capacity Building through orientation and awareness campaign for social mobilization

The project organized awareness campaign for climate resilient WSP to mobilize community people to take necessary measures against hazardous condition from point water sources to water consumption at HH level during disaster and normal period. A variation of activities was carried out including observation day, courtyard meetings, folk song, billboards, consultation, group discussion and drama which covered various socio economic factors, such as gender, age, occupation, institution, location, and economic class, relating to WSP and resilience to the changing climate. The campaign programmes were facilitated by trained field mobilizer with coaching and mentoring support of zonal staff of the project. They delivered the sessions addressing water quality issues, steps of water safety plan (source to consumption), effects of climate/disaster and mitigation measures, responsibilities of community people and the different institutions.

Directly 25,930 (M=6,482, F=19,448) community people received updated information, knowledge and skill through the mentioned activities on climate resilient WSP and indirectly 204,304 (M=100,109, F=104,195) populations were covered. This sums up to around 92% of the total population of the working unions being covered both directly and indirectly through this project.

Table 2: Beneficiaries were reached by orientation and awareness campaign

Sl.	Activities	Quantitative Progress		Beneficiaries (Direct and indirect)		
		Target	Achievements	Total Beneficiaries	Male	Female
1	Observe Sanitation Month (Rally, mass announcement, hand washing day, Discussion, School Hand washing)	8	16	12,200	5,978	6,222
2	Courtyard meeting	144	180	10,638	5,213	5,425
3	School session	NA	90	12,396	6,074	6,322
4	Cable TV network for WSP message dissemination	NA	12	102,000	46,200	55,800
5	Folk song, Jaari Gaan	NA	16	45,000	22,950	22,050
6	Demonstration of renovation of water facilities	NA	99	30,000	14,700	15,300
7	Billboard	9	9	18,000	12,600	5,400
Total				**230,234**	**113,715**	**116,519**

Sanitation Month

The community people observed sanitation month 2017 in 8 unions through school session, hand washing with school children, stage drama on WSP by local cultural group with participation of Union Parishad Chairman, Member, Female Members, DPHE representative, Health Assistant, Family

Planning Assistant, and Family Welfare Worker working at Union level, Students, and community people. The communities organized rally, mass announcement, and discussions on the issue of water safety plan, importance of hand washing.

Courtyard Meeting

Community people with different age group of female attended the courtyard meetings. Union facilitators conducted the sessions and discussed on the issues of water safety plan including safety of water source, collection, transportation, preservation, and use. They also discussed on climate resilient WSP issues, and the responsibilities of household members.

School Session

More than 12,396 school students attended the sessions on Water Safety Plan including hand washing practices, contamination sources of water from source to consumption, health effects and taking corrective measures.

Folk song, and drama

A local cultural event like Pot, folk song and drama on the WSP issues was organized in the community where around 45,000 people both male, female and children attended and gathered information and messages that increased their responsibility and commitment. Out of that 450 students, 15 teachers, 8 UP Councillors, Official from DPHE and Health Department enjoyed drama specially its messages on climate resilient WSP.

Cable TV Network

The project has broadcasted message on WSP through local cable network at four areas as a recreation mechanism as well as informative message as part of the project. 102,000 people have been reached by this event and they are able to tell about the safe water, hazards and hazardous event and take actions for safeguard of water facilities against the hazards.

Households visit

The project has strengthened local leaders who have acceptability in communities and voluntary mentality. They are working as change agent to visit neighbours and counselling them on importance of water safety and how to make water points safe and resilient.

Billboards

The project has installed 9 billboards at public places (hat bazar and Upazila gate) in 8 unions and one upazila by putting key messages of WSP with photos. This is most convenient as it attracts people to see and understand. It has been reached around 18,000 people both male and female.

Figure: Billboard with Climate Resilient WSP Messages

b. Demonstration

The project did not have any provision for support to install or renovate water options for the people especially who were more vulnerable. However, as part of local capacity building and raising awareness among mass people, few demonstrations were done in some priority spots of the working unions in terms of vulnerability and influencing wider community.

In all 8 unions under 3 Upazilas, 106 renovation works (minor) were done like PSF repairing, repairing of tube-well platforms, repairing of Rain Water Harvesting System (RWHS), renovation of school and temple based rain water harvesting system, hand washing corner at school, shifting of toilet, etc. All these work were initiated with the consent of the Union WatSan committee, community people and DPHE through a participatory approach for selecting the neediest and poor people as well as the source from where the most people, school children will be benefited in collection of safe water.

Rain water harvesting systems were introduced as an alternative means for climate resilient water source. This would make the households and communities more resilient to extreme climates, especially when other water sources become contaminated. Platforms for Tube wells were also repaired and raised with keeping 10 years return period of flood or cyclone in mind.

Outcome:

- A total of 350 students get safe water,
- A total of 70 HH get safe water from RWHS,
- A total of 400 beneficiaries get TW water,
- A total of 140 HH get safe water from renovated PSF.

c. Mobile based monitoring

With the recent trend in increased usage of mobile phones, it has become more easily accessible, affordable, available, efficient and effective to communicate with people through this technology. In social research study, the use of mobile phones has introduced a smart solution in collecting data more efficiently and accurately.

Under the "Development and Implementation of Climate Resilient Water Safety Plan in Vulnerable Rural Communities of Coastal Areas", one training was initiated on mobile based online monitoring system for 25 participants, including users, health staff, public representative, in Dacope Sadar Union with a view to assess the WSP situation of that particular community by the community people, themselves, for better awareness on its implications and impact. This training was conducted with the thought to build the capacity of the local government stakeholders to adopt the use of mobile based tool for effective means of monitoring and data collection (Baseline, end line, study etc.) in the future.

The questionnaire was developed focusing on some major areas like the 5 steps of WSP, sanitation and hygiene situation assessment, to assess the further need for development of a climate resilient water safety plan and preparation by the community and other stakeholders.

5. BASELINE VERSUS ENDLINE SURVEY ANALYSIS

a. Household survey of KAP

Like KAP baseline survey, same sample size, tools and techniques were used for conducting KAP end line survey. Apps were used to collect household data. Same sample size and parameters for water sources and household storage were tested. All parameters were tested by using field kits except E. Coli of Dacope and Mathbaria Upazilla which was tested in DPHE Lab, Barisal.

The main objective for conducting a KAP survey for household level was to know the changes of hygiene behavioural practice and people's perception in comparison with baseline and end line study. Also to understand people's perception on the impacts of climate variability and extreme weather events on the sources of drinking water facilities. Moreover, to know the climate adaptive measures or solutions that the communities have been taking.

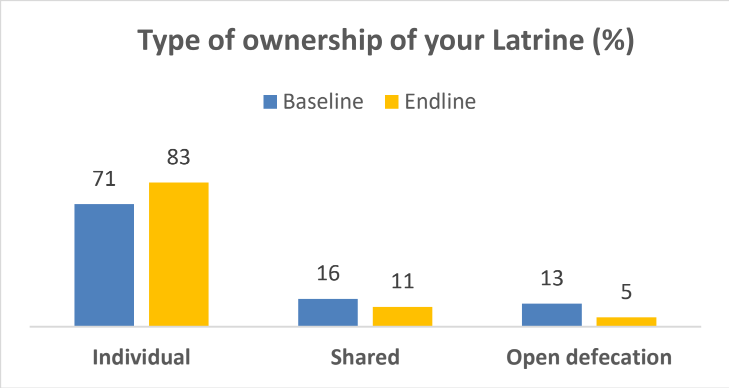
Overall we saw a positive change when comparing the baseline to the end line data in terms of sanitation, water and hygiene situation. User's knowledge on water source including availability, accessibility and functionality significantly increased as well as in terms of proper collection, transportation, storage as well as consumption of safe water. The response of community and other stakeholders were also found to be very positive and effective towards the wider promotion of climate resilient WSP.

These positive impacts can be attributed to the project's initiatives towards promoting social awareness campaign, demonstrations and linkage building with the sanitation entrepreneurs for safe sanitation practices.

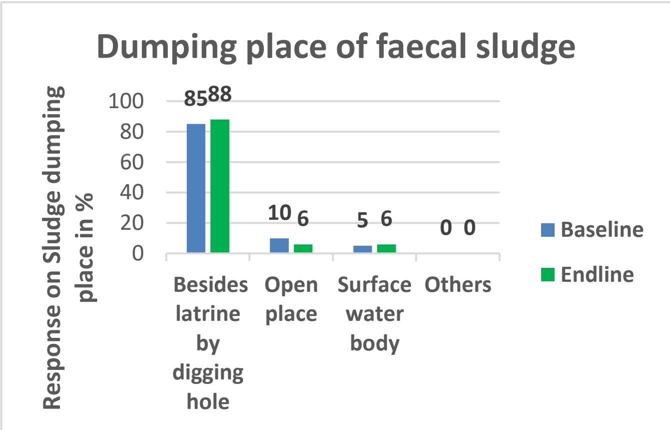
Based on both the baseline and end line data below are some key findings:

Sanitation Situation

Considering the findings of End line survey, it is revealed that the percentage of households having their own latrines have increased from 71% to 83%. Therefore, the attitude of sharing latrines and habits of open defecation decreased to 11% and 5% respectively. The cleanliness of latrine also increased from 66% to 86%. These change can be accounted to the project's intensive social awareness campaign, linkage building with the sanitation entrepreneurs for safe sanitation practices. The use of individual latrines, especially climate adaptive latrines with raised basement account for the climate resilient changes in the practice of the users.

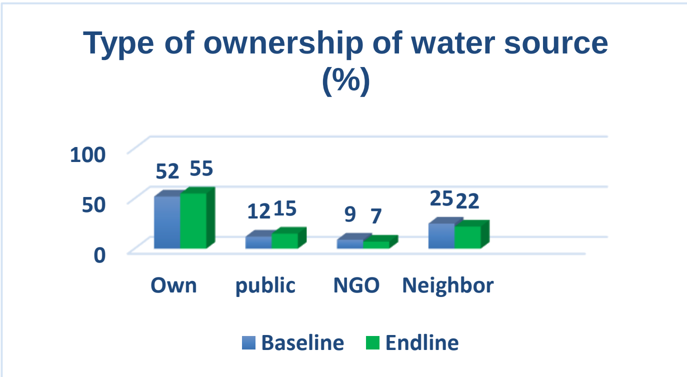


Faecal sludge dumping besides latrine by digging hole also increased from 85% to 88% whereas defecation in open spaces reduced from 10% to 6%. These behavioural changes can again be accounted to the project's capacity building and awareness initiatives. This better management of faecal sludge leads to lower contamination of water during extreme weather events like cyclone, inundation, high tide.

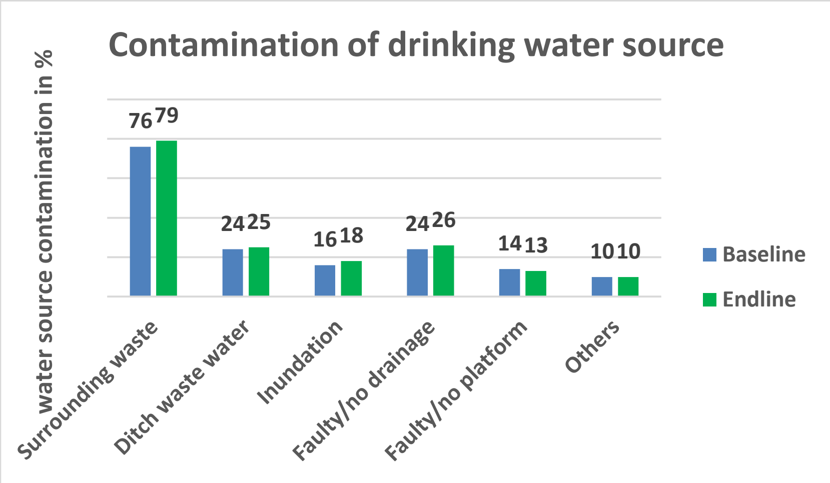


Water Situation

The study revealed that the ownership of water source increased from 52% to 55% which automatically decreased the rate of sharing water sources with neighbour from 25% to 22%. This change can be accounted through project's initiatives in awareness campaign, demonstration and exposure visits. During demonstration, the project also considered climatic issues like cyclone, tidal surges, saline intrusion as these areas are climate vulnerable areas. Thus making communities more aware about climate adaptive water sources, especially raised tube well that led to greater ownership of water sources and hence more adaptive to deal with natural disasters.

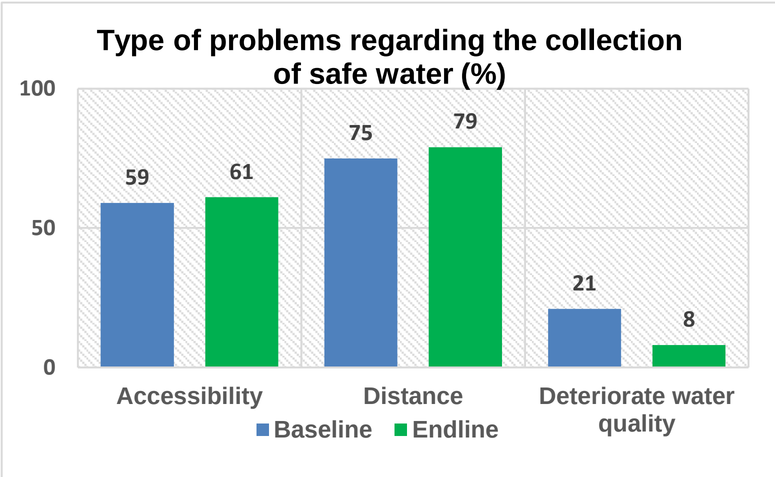


Response against contamination of drinking water source by surrounding waste increased from 74% to 79% respondents. This shows users knowledge of what accounts for contamination in terms of water quality increased.

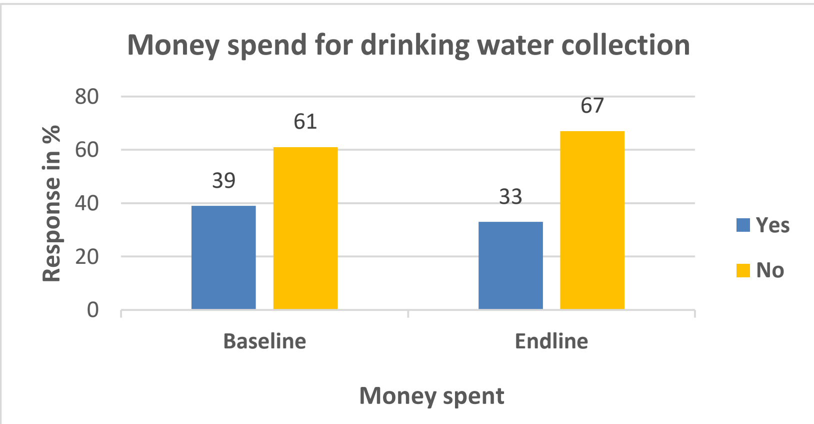


Accessibility of water

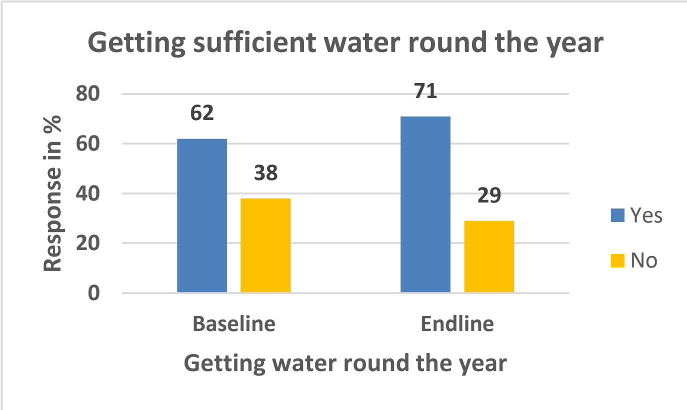
People are facing problem regarding collection of safe water. When asked for reasons behind this problem most respondents commented that distance was the major issue (79%), then accessibility (61%), and deterioration of water quality (8%) accordingly. As their knowledge of what accounts for safe water increased they were going to greater extent in search for better quality water. Hence we see a rise in the percentage of people travelling greater distance for safe water from 75% in baseline to 79% in the end line. However, the rate of accessibility of said safe water did not increase by that much. In some cases, this lack of accessibility can be accounted to the climatic impacts that these regions were facing.



In regards to money spent for collecting drinking water, the end line survey showed a decreased from 39% to 33%. This can be due to the seasonal variation and proper operation and maintenance of the water source. Hence the households are getting better and safe drinking water without needing to spend as much money as before.



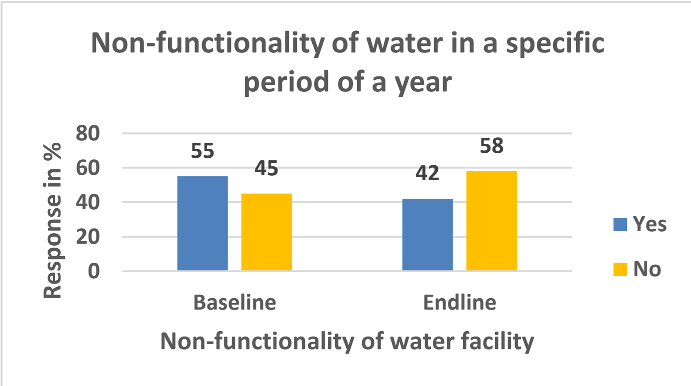
Availability of water



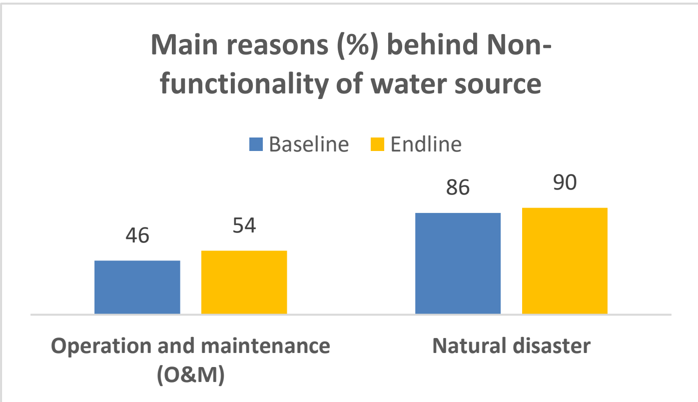
Amount of water the users are getting around the year increased from 62% to 71%. This is due to different reasons including better operation and maintenance of water source and use of rain water.

We see that during management of crisis period like cyclone and other disasters, users were also inclined to consume less contaminated water and consume less water overall.

Functionality of water source



Non-functionality of water source in a specific period of a year changed from 55% to 42%. Of which variations were found highest in first quarter (January-March) and second quarter (April-June) of the year. During the last two quarters of the year was seen to be decreasing.

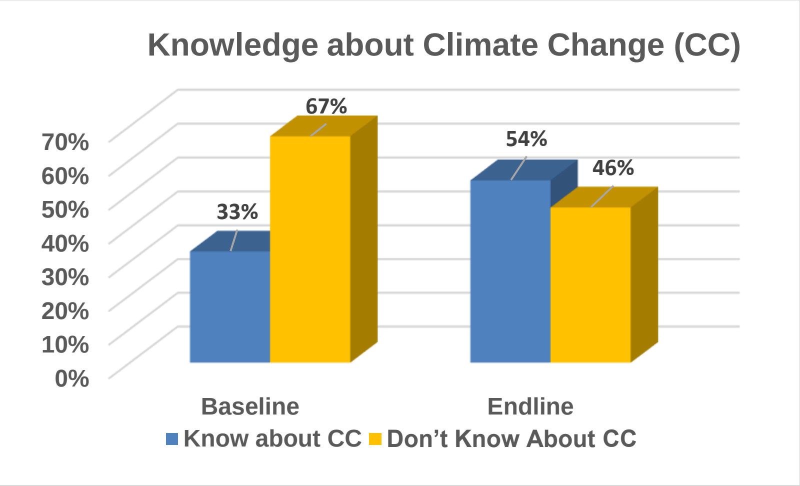


Response against main reasons behind the non-functionality of water source changed from 86% to 90% in case of natural disasters and 46% to 54% in case of operation and maintenance. Response against spending money for operation and maintenance of water source during last 6 months reduced from 42% to 38%. More than 150 BDT was spent for operation and maintenance by the users which reduced from 50% to 47% and users spending 50 -100 BDT increased from 18% to 33% in comparison with baseline.

The fall in the number of water sources which are non-functional can be accounted for people's adaptation of climate resilient WSP. We see that one of the main reasons that the respondents accounted for behind the non-functionality of water sources were natural disasters. Thus by making their water sources more climate resilient they are getting more adapted and thus increasing their functionality of their water source. We see an increase in people's knowledge of what reasons could be behind this non-functionality of water sources as now more people are accounting natural disaster and lack of operation and maintenance as compared to baseline.

People's perception about Climate Change

Peoples knowledge about climate change increased from 33% to 54% in comparison with baseline study report.



This could be accounted to the courtyard sessions, media advertisements and dissemination of information through neighbours.

62% of the respondents observed changes in temperature, humidity, rainfall and seasonal variations and extreme weather events those are cyclone, storm surges, tidal surges salinity and cold.

Around 79% of the respondents answered in favour of natural disaster that occurred in last 5 years which was 74% at baseline. During last disaster, 78% respondents replied that their water sources were safe which 62% at baseline. These results account for the positive impact that the project have created in the knowledge and adaptation of climate resilient WSP.

During disaster, 71% respondents collected drinking water from neighbours which was same as baseline; purchased water reduced from 16% to 15% and collected water from union parishad which was increased from 6% to 12%. Again people were more aware of what accounted for safe water and when adapting to measures that create more resilience to climate changes and natural disasters.

During disaster, people faced problem for collecting drinking water, however this percentage reduced from 40% to 34% after our project activities. Moreover, during disaster, response on health related diseases reduced from 41% to 35% and intensity of salinity both in ground and surface water reduced from 35% to 31% in comparison with baseline. This indicates the positive impact of the project on raising awareness among the respondents regarding the understanding of disaster and salinity.

People's perception against drinking water quality

Respondents believed that the testing of water parameters were to be done by Govt., NGOs and themselves. The mostly tested parameters were arsenic, Iron, E. Coli, salinity/ chloride and others. Respondents were found more conscious about E. Coli with 53% of the population now considered E. Coli as a factor against safe water compared to only 10% in the baseline. Majority of the users now knew the test result and necessary measures against the water quality which was beyond the limit.

Collection to use of drinking water – Safety measures

Water Source: Cleaning of water delivery system during collection increased from 42% to 78%.

Collection: More than 96% respondents answered that they clean their water pot during collection which was 79% during baseline.

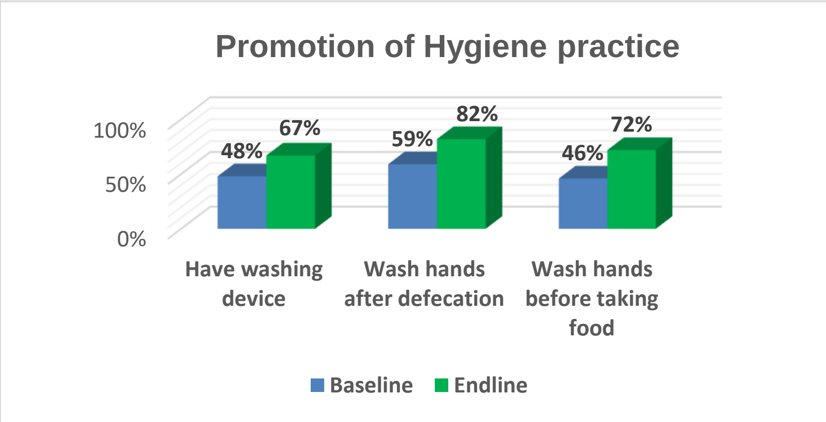
Transportation: The use of cover with pot during transportation of water increased from 94% to 61%. Putting hands inside pot during transportation reduced from 27% to 11%.

Storage: 93% respondents answered that they keep their water pot in a suitable height by using cover which was 64% at baseline.

Use: Around 96% respondents answered that they clean their glass during water use which was 85% at baseline.

HH hygiene situation

Having hand washing device increased from 48% to 67%; washing hands after defecation also increased from 59% to 82% and washing hands before food intake increased from 46% to 72%.



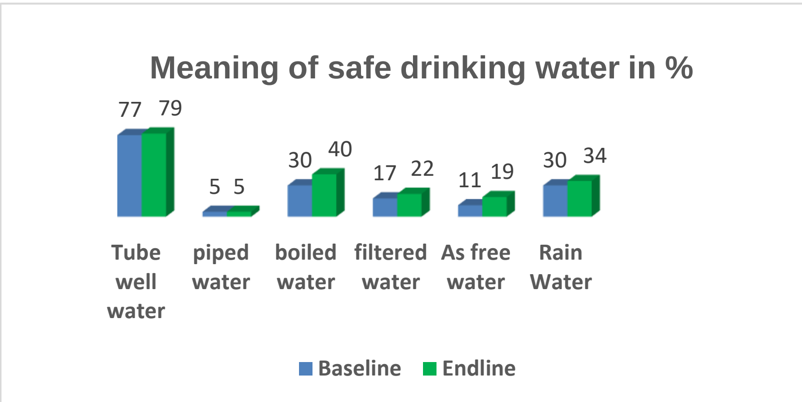
Response for the health risks associated to lack of hygiene practice increased from 81% to 98%.

Response regarding factors contributing to the good health changed from 47% to 73% for safe water use, sanitation 20% to 42%, hand washing from 37% to 55% and hygiene practice remained the same.

Awareness on safe water and health

Water borne diseases: Majority of the respondents answered that the prevalent water borne diseases in the area were diarrhoea, cholera, dysentery, then typhoid, jaundice, skin diseases. Most dominating one being diarrhoea which was around 96% compared to 75% at baseline. The trend of incidences of the water borne diseases over time increased from 76% to 96%. This was due to the prevalence of water borne diseases being high during dry period.

For children under the age of 5, one child per family being affected by diarrhoea reduced from 65% to 60%.

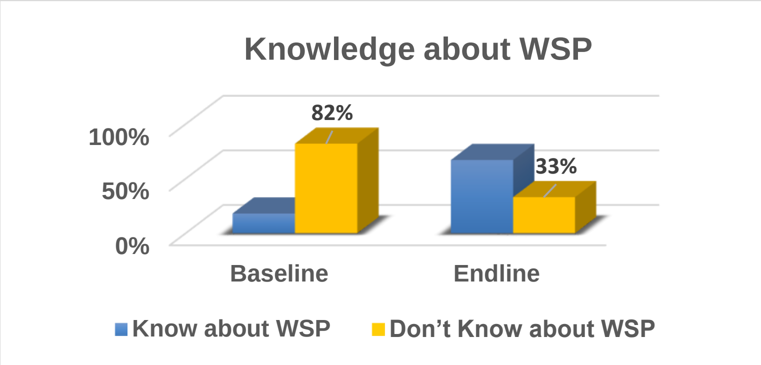


Safe water: The meaning of safe drinking water being tube-well water increased from 77% to 79%, boiled water from 30% to 40% and rain water from 30% to 34%.

Knowledge about the arsenicosis diseases also increased from 36% to 49%.

WSP: More than 67% of the respondents knew about the WSP which was only 18% at baseline.

Response for reducing microbial contamination by WSP reduced from 78% to 53%; WSP for good health increased from 50% to 66% and WSP for reducing diseases increased from 27% to 73%.



b. Water Quality

A total of 214 water samples for microbial parameters (E. Coli) were tested both at source and household storage level. The low risk level at source water was found decreasing; high and very high risk level is increasing. This was due to the erratic rainfall last October which caused inundation in some project locations and contamination during collection, especially for rain water harvesting. However, for household storage water, the low risk and medium and very high risk level decreasing as compare to baseline. This positive change can be due to improved hygiene practice, WSP knowledge and shifting of water source in some cases.

There is a good correlation between E. Coli and SI risk score as compared to the baseline which will guide users, researcher and practitioners to develop and implement climate resilient WSP.

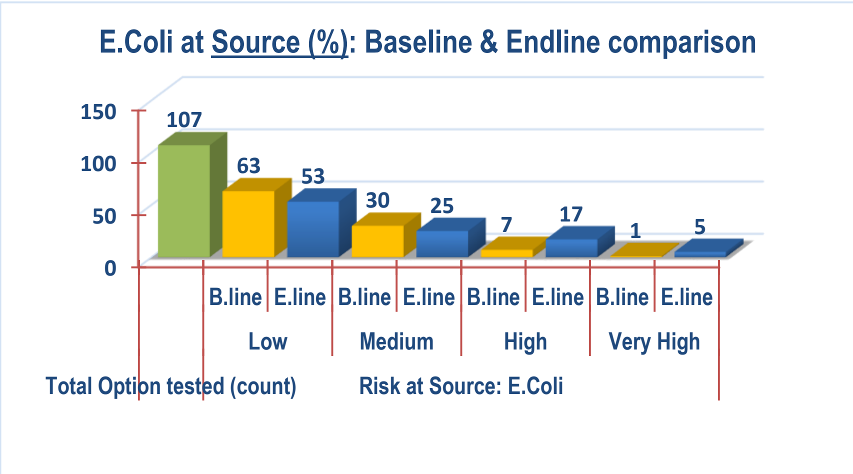
The highest contamination of salinity found beyond limit was around 60% of water options in Dacope sadar union and 43% of water options in Gulshakhali union. Other parameters like arsenic and nitrate were found within the Bangladesh standard for of the 100% water source.

The mentionable activities which acted to attain the said changes regarding water quality were WSP related awareness campaign (community session, bill board, folk song etc.), demonstration (rehabilitation of Tube well-platform, drain, shifting of toilet) and water quality test and result sharing.

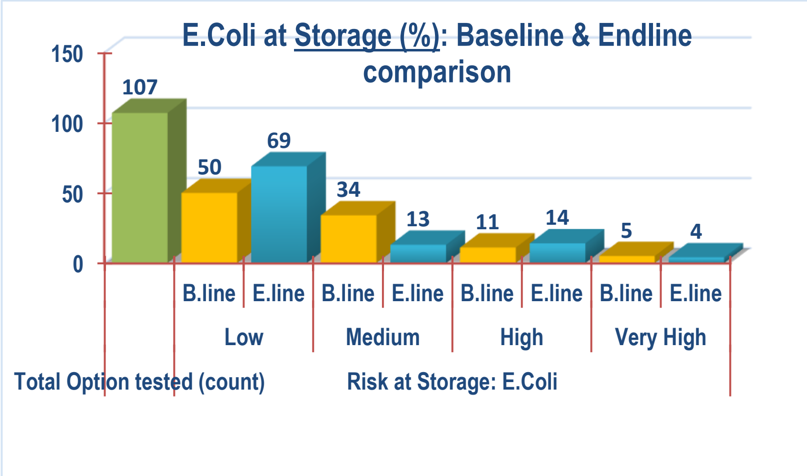
10% of the surveyed HH's water sources were tested both in baseline and end line survey for arsenic, E. Coli, salinity and Nitrate. The storage water from the same HH were tested for, E. Coli and Nitrate (where applicable). All parameters were tested by field kit at field except E. Coli test which was done in DPHE lab at Barisal during the end line survey due to the lack of test membrane. The parameter wise test results are given below:

Microbial

A total of 214 water samples for microbial parameters (E. Coli) were tested with 107 being tested at water sources and 107 at household storage level (see Annex - 1).

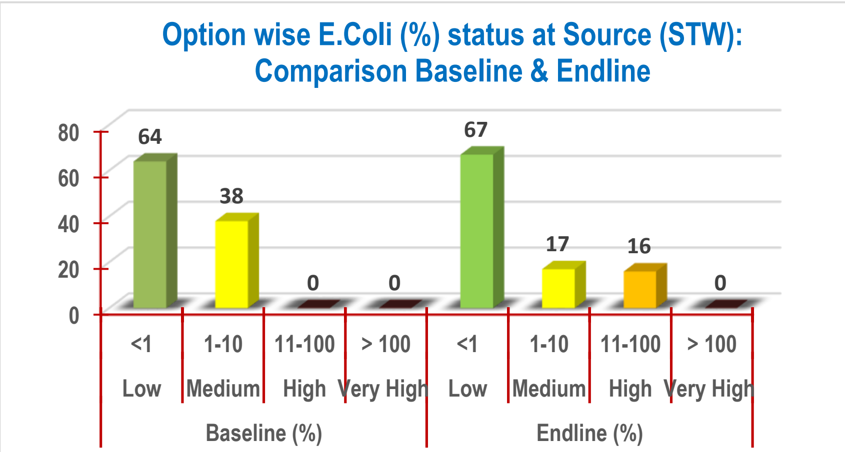


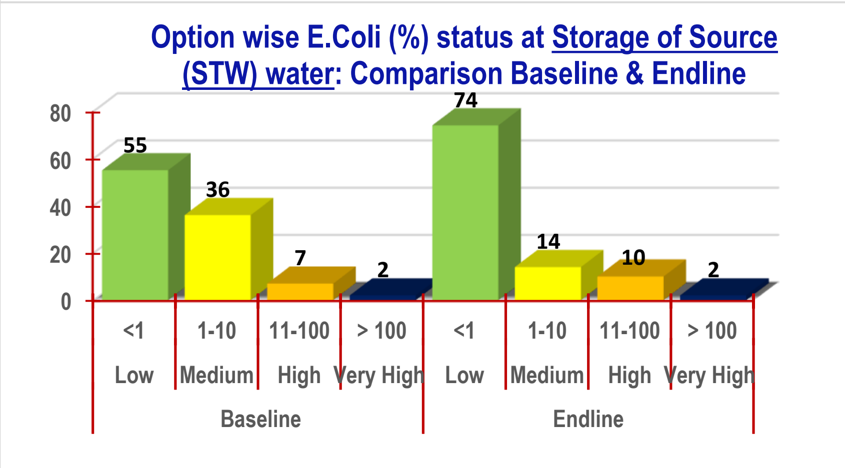
The low risk level at source water was found decreasing and high and very high risk level was seen to be increasing. This can be due to the erratic rainfall in last October which caused inundation in some project locations and contamination during collection, especially rain water harvesting. The mostly affected water options were DHTW, SHTW and Pond. But, at household storage water, the low risk level of E. Coli count was gradually increasing; and medium and very high risk level is decreasing as compare to baseline data. This positive trend shows, due to the project campaigns and demonstration, people were undertaking measure to ensure proper and safe storage of water. Particularly SHTW, DHTW, PSF, Ring well and protected pond resulted low risk level compare to others with baseline. This shows positive attitude towards climate resilient WSP adapted due to the project activities.



When comparing the risk level associated for each of the water sources separately for source and storage of water with baseline, we see the following results.

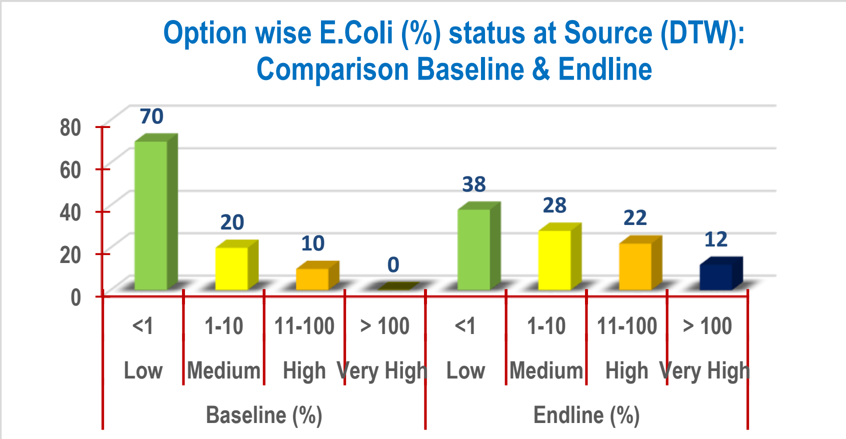
For STW, when comparing the presence of E. Coli with the water source we see a slight increase in the level of low risk. We also see a gradual fall in the medium level risk. However, there is a significant increase in the percentage of people with the level of high risk. Thus, we cannot present any conclusive results based on this analysis for the STW at source. This again could be due to the sudden inundation that the coastal areas faced during the project period.



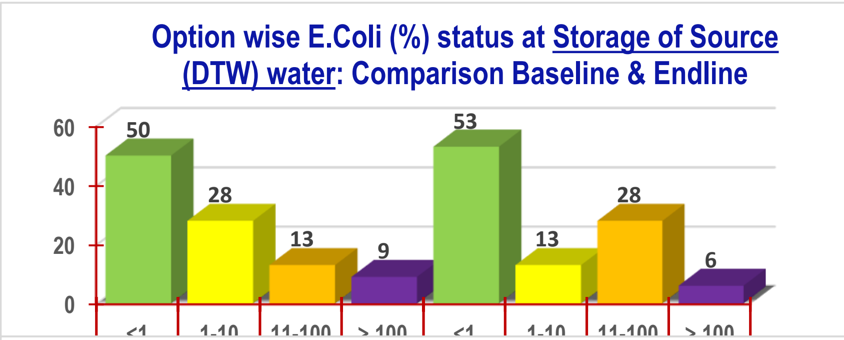


However, for the storage we see that a significant positive impact as compared to the baseline data. The percentage of risk for low levels significantly increased and medium levels decreased and high level increased. This show the positive uptake of climate resilient WSP. With intensive motivation and awareness campaigns conducted through the project, the communities were aware on how to properly treat and keep water safe at storage levels. This shows that even with contaminated water at the source the communities are capacitated through the project to use different methods such as using bleaching powder or alum to treat the storage water and keep it safe.

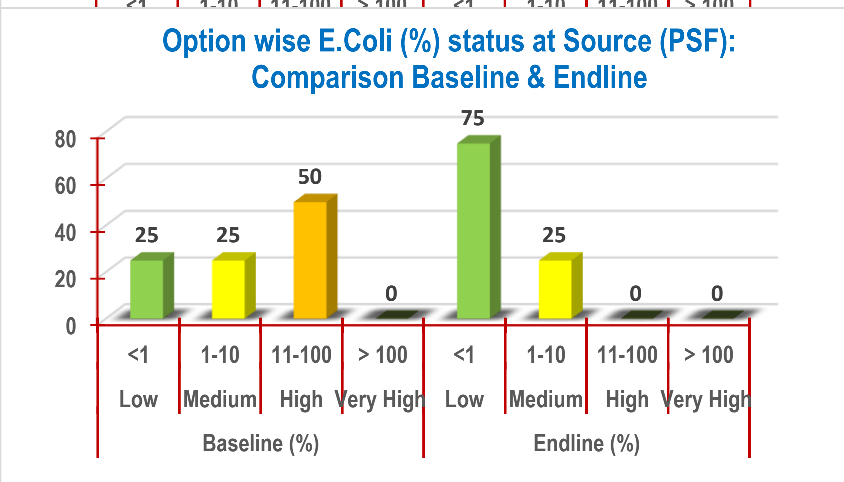
For the case of DTW, we see that for water source risks associated with E. Coli at low level is falling with risks at medium, high and very high level are gradually increasing. This fall in the quality of the water at source for DTW can be attributed to the inundation that were seen at the project sites.



The same trend is seen for storage of water and the status of E. Coli, with low risk levels increasing and medium and high risk levels increasing. This is due to the contamination already present at source.

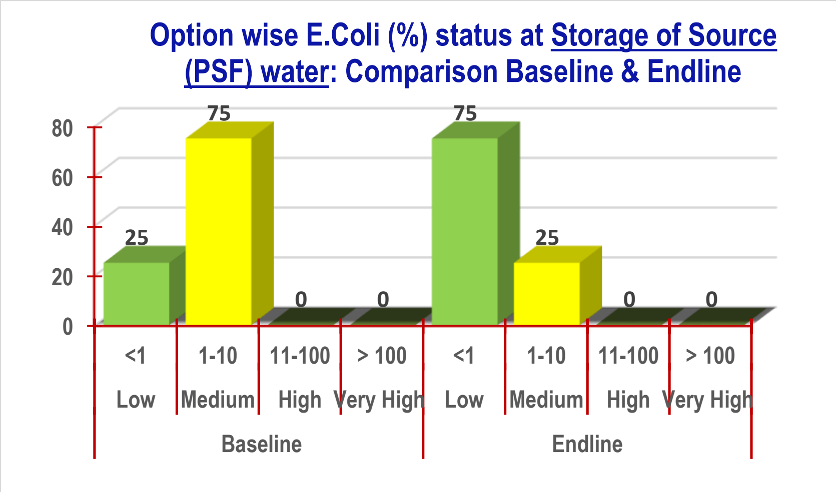


For PSF, we see a significant positive impact for both in terms of source water and storage water when comparing with baseline. For source water, we see the risk percentage for low increasing and for high is falling to zero.

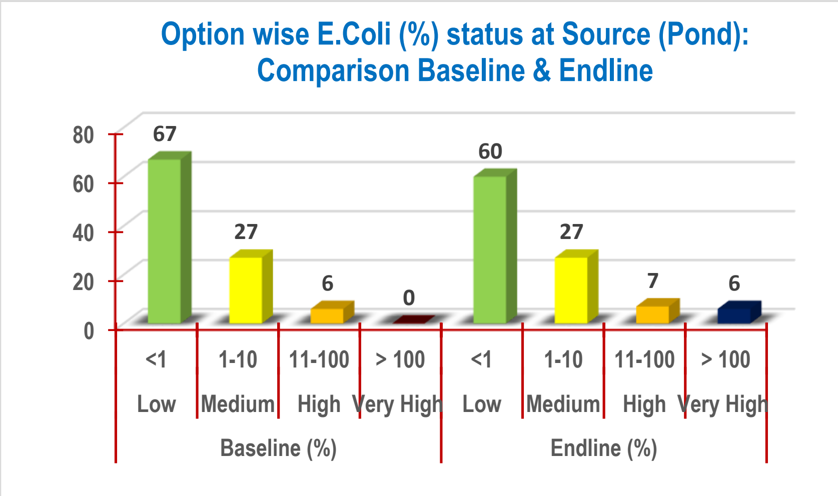


In terms of the status of E. Coli with respect to storage of source water of PSF we see an increase in the risk score for low levels and a fall in the risk scores for medium level.

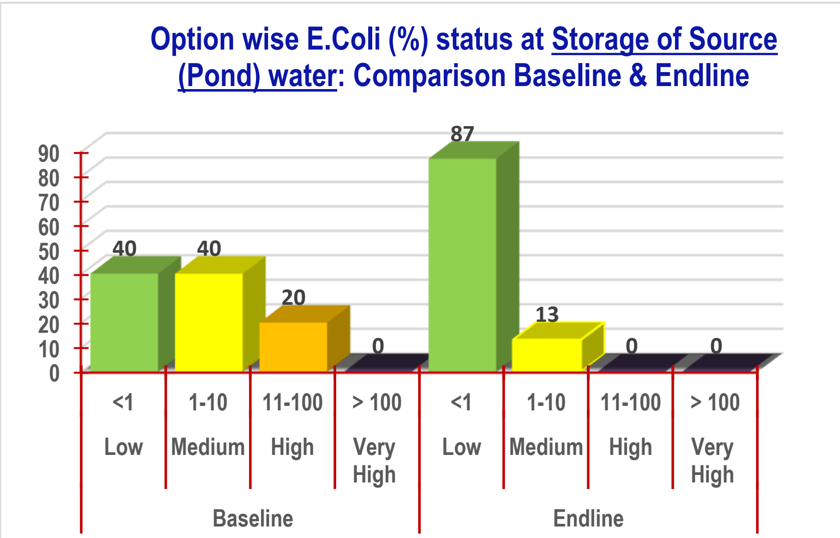
Both these positive impacts can be attributed to the uptake of climate resilient WSP promoted through the project and people became more aware about the hygienic practices.



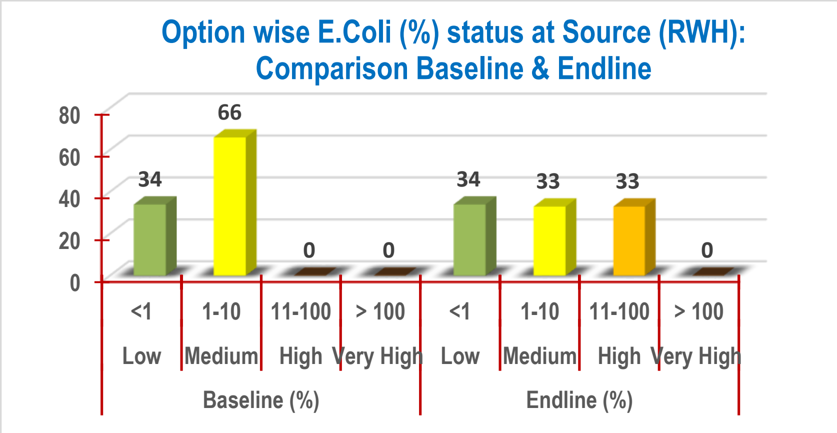
For source water of Ponds, we see a fall in the risk scores at low level and increase at high and very high levels. These results could be due to the erratic rainfall faced in the project areas which caused extensive inundation.



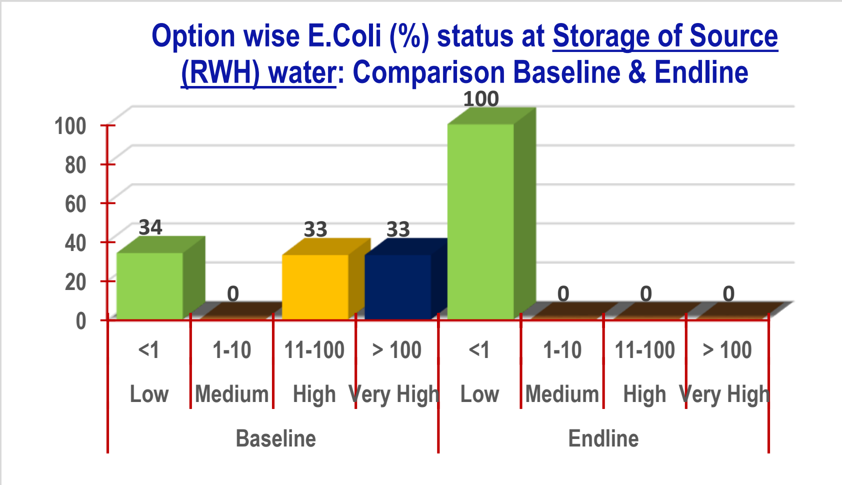
However, when we see the status of E. Coli in terms of storage of pond water as the source we see a significant positive change when compared to baseline data. The risk scores at low level increased and at medium and high levels decreased substantially. This change to higher percentage of people having access to safe water at storage even when the source water was seen to be more contaminated shows positive adaptation of climate resilient WSP by the communities through the project.



Almost similar trend can be seen for RWH as was seen for Pond. The percentage of population at high risk level increased. This could be attributed to the erratic rainfalls faced in the project areas.

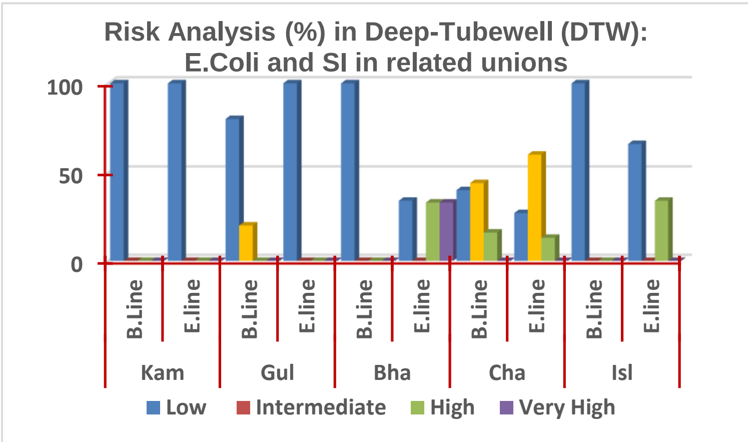


However, we see that 100% of the population are a low risk level when compared to the baseline data for the storage of RWH. This shows the positive motivation created through the project activities towards adaptation climate resilient WSP. Even with extreme weather with unexpected inundations the communities were able to properly adapt and treat the storage water by using bleaching powder, alum etc., even when a significant portion of the source water was contaminated.

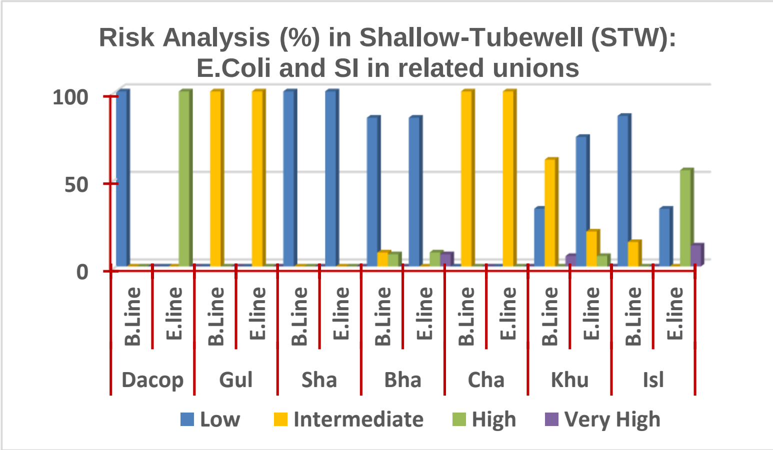


Correlation between E. Coli and SI risk score

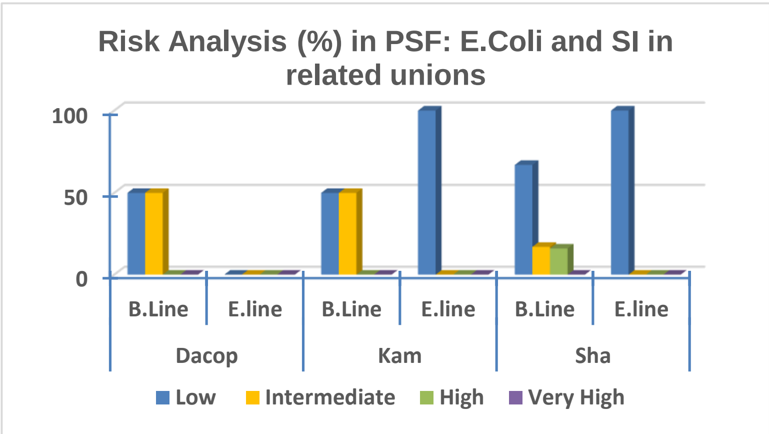
This analysis is done on the basis of finding a relation between sanitary practices and the prevalence of water borne diseases (namely E. Coli). On the basis of the sanitary inspection risk score and E. Coli test result, a correlation was made and shown in the graph and annex-2. It was revealed that DHTW of Kamarkhola and Gulshakhali union is in 100% low risk. High risk and very high risk of DHTW increased in Islampur and Chafaldungi union respectively which can be due to the stagnation of water during the excessive rainfall.



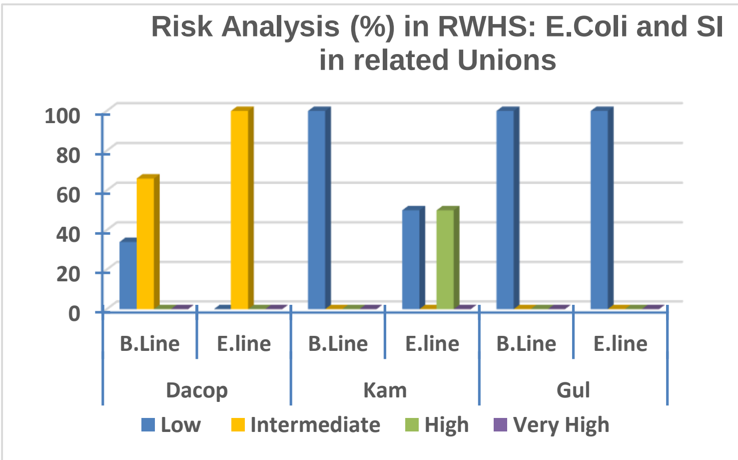
For the case of SHTW, Shapleza and Bharuakhali union are almost within low risk category. The intermediate risk of Dacope and Islampur union is increasing. Gulshakhali and Chafaldungi union are within the intermediate risk which is same as baseline. Low risk of Khurushkul and Islampur union is increasing and decreasing respectively. These increase in risk scores can be due to the change of hygiene behaviour practice, operation and maintenance.



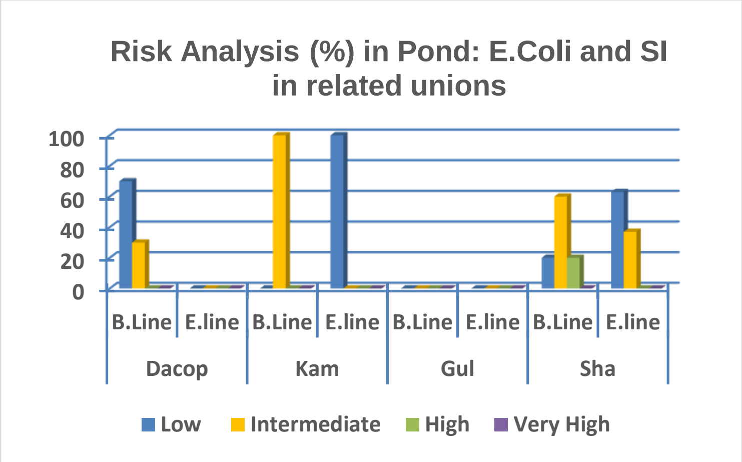
100% PSF of Kamrkhola and Shapleza union is within the low risk category due to enhance the operation and maintenance of the users. PSF is an alternative and climate resilient water option.



100% RWHS of Gulshakhali union was within the low risk category which can be due to the improvement in operation and maintenance of the system. Intermediate and high risk of Dacope sadar and Kamarkhola union respectively are increasing. This is again due to the erratic rainfall during last October.

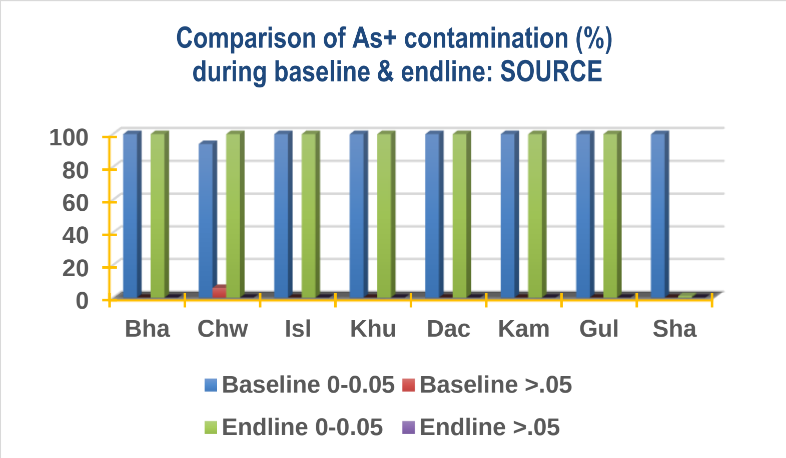


100% pond of Kamrkhola union and 60% pond of Shapleza union are within the low risk category which indicates the positive trends of changing. This was due to the use of bleaching powder, alum before drinking.



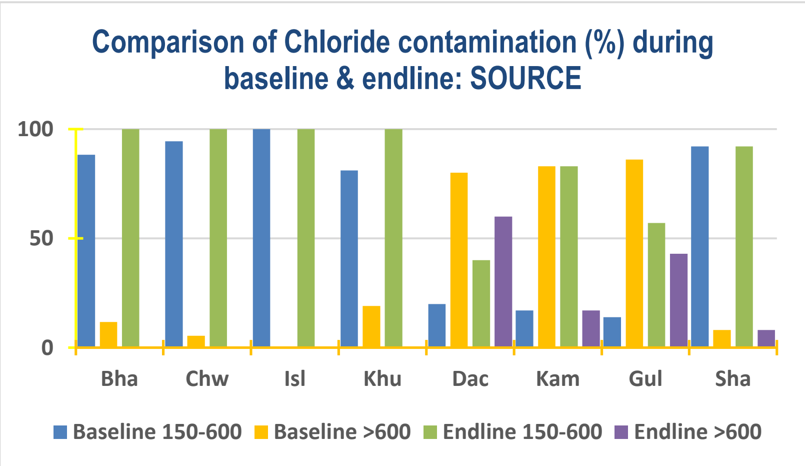
Arsenic

82 water options were tested where 100% option were within the acceptable limit of Bangladesh standard (0-0.05 mg/l) as compared to baseline 98%. Out of 3 geographical locations, highest arsenic contamination was found in Khurushkul union of Cox's Bazar district. The table indicates seasonal variation of arsenic concentration in ground water and the affected people have switched to safe water sources like nearest green STW, household arsenic removal filter, rain water collection during monsoon. Thus, the arsenic concentration was found less in comparison with the baseline data. There was only one tube-well found to have arsenic beyond limit which was red marked for prohibiting to use in drinking and cooking purposes.



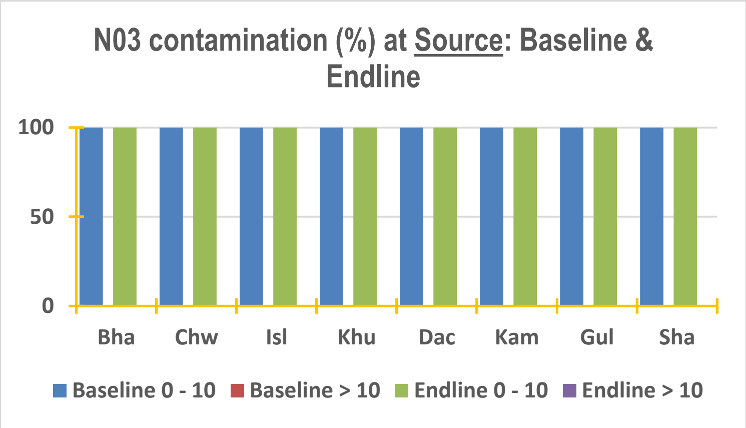
Salinity

103 water options were tested where 92% options were found within the acceptable limit of Bangladesh standard (150-600 mg/l). Out of 8 unions, contamination of salinity was found highest in Dacope and Gulshakhali union under Khulna and Pirojpur district respectively. The highest contamination was found in Dacope sadar union around 60% options beyond limit and 43% options in Gulshakhali union.

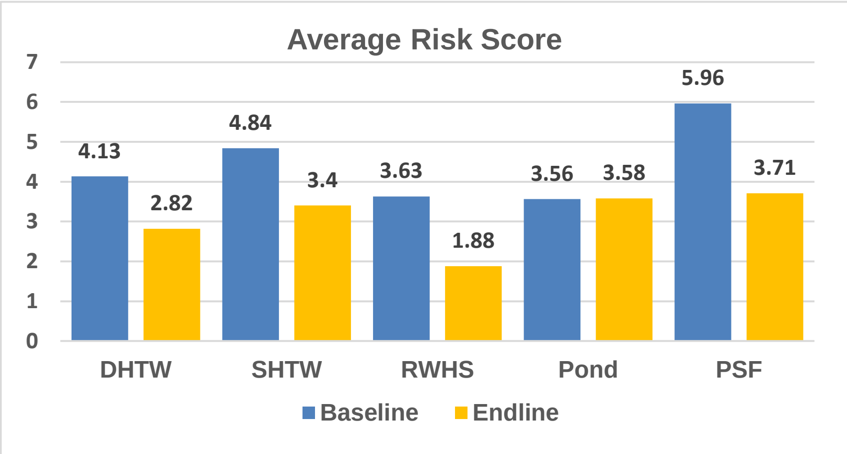


Nitrate (NO3)

106 water options were tested where 100% options were found within the limit 0-10 of Bangladesh standard which is same as the baseline data.



c. **Sanitary Inspection (SI) Situation**



During baseline and End line survey, sanitary inspection was done by using SI format for all water facilities which are used by the sampled households with a view to identify the category of risk (Low to very high) of water facilities and draw a correlation with the E. Coli. The comparative analysis of their risk scores of baseline versus end line is given in the graph. The summary findings reflect that the option wise risk scores of the water facilities are gradually decreasing due to the practice change of the users through raising awareness and increasing knowledge on the importance of WSP.

6. CHALLENGES

During implementation of climate resilient WSP, it was revealed that some support especially in terms of demonstration and introduction of alternative water option was needed to improve the safety of water for the people who are poor, living in hard to reach area and pocket areas. Also, renovation of water facilities and relocation of water sources because of hazards only through motivation, linking and networking was a challenge.

Moreover, due to space constraint it is hard to maintain adequate safe separation space between latrine and tube well.

Within the very limited time frame, the project had to achieve significant improvement and changes regarding WSP.

7. LEARNING

The climatic effect is gradually increasing on environment and extreme weather events especially seasonal variations, increasing temperature, decreasing rainfall intensity and unusual nature of rainfall that deteriorate the water quality, accessibility, availability, and functionality. Almost all water points are vulnerable and robust alternative technology is needed to eventually make the communities climate resilient in terms of WSP.

People's perception that water coming from any form of technology is safe. However, in reality this is not always the case. For instance, people perceive that water out of tube well is always safe, however, these can be contaminated with pathogen or other chemical contaminants. Thus specific effort needs to be taken in terms of building knowledge of the community on these misgivings and what constitutes safe water.

Most of the present technology in terms of water point is vulnerable due to climate variability and extreme weather events. With changes in climate conditions, frequency of natural disasters has also increased leading to damage of the present water source, e.g. inundation and damage of water points. Thus, to overcome such challenges present water options need to be adapted with keeping in mind changes in future climatic conditions, like, raising the platform and anchoring the tube-well to it. Hence, focus need to be given in building the knowledge and awareness of the communities about the effect and adaptation of climate change in the WSP.

Climatic factor, Environmental factor and Human factor – it often becomes difficult to differentiate among these factors. Many human factors are aggravating climatic factors. For instance, the salinity level in some of these areas are increasing due to climate change impacts. However, the rate at which they are increasing might be more due to the shrimp culture that is being done in these regions which brings saline water into farm lands. Hence, communities need to be sensitized about other factors that might influence or aggravate the impacts of climate changes and tailor the interventions accordingly.

The correlation between microbial water quality and SI risk score is critically important. Analyses of SI indicates that the **microbial water quality** varies with change of practices of water safety plan by the users.

The communities are not forward thinking. They are not making decisions based on how the climate has changed in the last few decades and how it can change even more in the future. Rather most of the people are installing new technologies or changing the life style based on recent weather changes rather than long term climatic changes. The existing community groups, health workers, religious leaders, DPHE tube well mechanics and CBOs can play an important role for the sustainable promotion and scaling up of climate resilient WSP through sensitisation, capacity building and financial safety-net.

8. WAY FORWARD

Demonstration of climate resilient WSP is important and effective for creating awareness, capacity and skill on operation and maintenance of water facilities.

Incentive for R&D needs to be put in place for introducing and promoting robust alternative technology. Effective communication tools and monitoring mechanism should be developed for the promotion of WSP. National communication campaign is needed to sensitize people in mass.

Strengthening linkage, networking and relationship among community, local government institute, and Govt. line departments is important to leverage resources and mainstream WSP into the government policies and projects.

Allocation of fund should be considered by the union parishad for operation and maintenance, upgrading of existing infrastructures into climate resilient ones and installation of few climate resilient infrastructures to ensure serving the people for long run, withstanding climate change impacts.

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Annexure 1: Water quality test data of baseline and end line survey

E.coli At Source		**Baseline**				**Endline**			
		Low	**Medium**	**High**	**Very High**	**Low**	**Medium**	**High**	**Very High**
Option Tested	**Union**	**<1**	**1-10**	**11-100**	**> 100**	**<1**	**1-10**	**11-100**	**> 100**
18	Bharukhali	15	1	2	0	13	0	2	3
18	Chawfaldandi	7	9	2	0	2	10	4	2
18	Islampur	16	2	0	0	8	4	6	0
22	Khurushkul	9	12	0	1	16	4	2	0
5	Dacop	2	2	1	0	0	1	3	1
6	Kamarkhola	4	2	0	0	4	1	1	0
7	Gulshakhali	6	1	0	0	5	2	0	0
13	Shapleza	8	3	2	0	9	4	0	0
107	**Total**	**67**	**32**	**7**	**1**	**57**	**26**	**18**	**6**

E.coli At Storage		**Baseline**				**Endline**			
		Low	**Medium**	**High**	**Very High**	**Low**	**Medium**	**High**	**Very High**
Option Tested	**Union**	**<1**	**1-10**	**11-100**	**> 100**	**<1**	**1-10**	**11-100**	**> 100**
18	Bharukhali	11	5	1	1	13	0	3	2
18	Chawfaldandi	6	7	2	3	4	8	5	1
18	Islampur	12	6	0	0	12	1	4	1
22	Khurushkul	12	7	2	1	20	0	2	0
5	Dacop	1	2	2	0	4	0	1	0
6	Kamarkhola	4	1	1	0	6	0	0	0
7	Gulshakhali	5	1	1	0	5	2	0	0
13	Shapleza	2	7	3	1	10	3	0	0
107	**Total**	**53**	**36**	**12**	**6**	**74**	**14**	**15**	**4**

Option wise E. Coli At SOURCE		Baseline				Endline			
		Low	Medium	High	Very High	Low	Medium	High	Very High
Option Tested	**Option Type**	<1	1-10	11-100	> 100	<1	1-10	11-100	> 100
40	DTW	28	8	4	0	15	11	9	5
42	STW	27	15	0	0	28	7	7	0
4	PSF	1	1	2	0	3	1	0	0
15	Pond	10	4	1	0	9	4	1	1
1	River	0	1	0	0	0	1	0	0
3	RWH	1	2	0	0	1	1	1	0
2	Ring well	0	1	0	1	1	1	0	0
107	**Total**	**67**	**32**	**7**	**1**	**57**	**26**	**18**	**6**

Option wise E. Coli At STORAGE		Baseline				Endline			
		Low	Medium	High	Very High	Low	Medium	High	Very High
Option Tested	**Option Type**	<1	1-10	11-100	> 100	<1	1-10	11-100	> 100
40	DTW	20	11	5	4	21	5	11	3
42	STW	23	15	3	1	31	6	4	1
4	PSF	1	3	0	0	3	1	0	0
15	Pond	6	6	3	0	13	2	0	0
1	River	1	0	0	0	1	0	0	0
3	RWH	1	0	1	1	3	0	0	0
2	Ring well	1	1	0	0	2	0	0	0
107	**Total**	**53**	**36**	**12**	**6**	**74**	**14**	**15**	**4**

Parameters: **As+ At Source**					
Option Tested	**Union**	**Baseline**		**Endline**	
		0-0.05	>.05	0-0.05	>.05
17	Bha	17	0	17	0
18	Chw	17	1	18	0
17	Isl	17	0	17	0
21	Khu	21	0	21	0
2	Dac	2	0	2	0
1	Kam	1	0	1	0
5	Gul	5	0	5	0
1	Sha	1	0	1	0
82	**Total**	**81**	**1**	**82**	**0**

Parameters: Chloride At Source					
Option Tested	Union	Baseline		Endline	
		150-600	>600	150-600	>600
17	Bha	15	2	17	0
18	Chw	17	1	18	0
17	Isl	17	0	17	0
21	Khu	17	4	21	0
5	Dac	1	4	2	3
6	Kam	1	5	5	1
7	Gul	1	6	4	3
12	Sha	11	1	11	1
103	**Total**	**80**	**23**	**95**	**8**

Parameters: NO3 At Source					
Option Tested	Union	Baseline		Endline	
		0 - 10	> 10	0 - 10	> 10
18	Bha	18	0	18	0
18	Chw	18	0	18	0
18	Isl	18	0	18	0
22	Khu	22	0	22	0
5	Dac	5	0	5	0
6	Kam	6	0	6	0
7	Gul	7	0	7	0
12	Sha	12	0	12	0
106	**Total**	**106**	**0**	**106**	**0**

Parameters: NO3 At Storage					
Option Tested	Union	Baseline		Endline	
		0 - 10	> 10	0 - 10	> 10
18	Bha	18	0	18	0
18	Chw	18	0	18	0
18	Isl	18	0	18	0
22	Khu	22	0	22	0
5	Dac	5	0	5	0
6	Kam	6	0	6	0
7	Gul	7	0	7	0
12	Sha	12	0	12	0
106	**Total**	**106**	**0**	**106**	**0**

Annexure 2: District wise correlation between E. Coli and SI risk score

RISK	Khulna District											
	Dacope Sadar Upazila											
	Dacop Sadar Union				Kamarkhola Union							
	STW		RWHS		DTW		RWHS		Pond		PSF	
	B.Line	E.Line	B.Line	E.Line	B.Line	E.Line	B.Line	E.Line	B.Line	E.Line	B.Line	E.Line
Low	0	0	0	0	100	100	0	50	0	100	0	100
Intermediate	100	0	33	100	0	0	0	0	100	0	50	0
High	0	100	33	0	0	0	50	50	0	0	50	0
Very High	0	0	34	0	0	0	50	0	0	0	0	0

RISK	Pirojpur District									
	Mothbaria Upazila									
	Gulshakhali Union				Shapleza Union					
	STW		RWH		STW		Pond		PSF	
	B.Line	E.Line	B.Line	E.Line	B.Line	E.Line	B.Line	E.Line	B.Line	E.Line
Low	40	0	67	100	0	100	0	63	0	100
Intermediate	20	100	33	0	100	0	80	37	17	0
High	40	0	0	0	0	0	20	0	50	0
Very High	0	0	0	0	0	0	0	0	33	0

RISK	Cox's District													
	Cox's Bazar Sadar Upazila													
	Bharukhali Union				Chaufoldangi				Islampur				Khuruskul	
	STW		DTW		STW		DTW		STW		DTW		STW	
	B.Line	E.Line	B.Line	E.Line	B.Line	E.Line	B.Line	E.Line	B.Line	E.Line	B.Line	E.Line	B.Line	E.Line
Low	0	85	0	34	0	0	17	27	57	33	50	67	11	74
Intermediate	46	0	0	0	0	100	33	60	43	0	0	0	28	20
High	39	8	100	33	100	0	50	7	0	55	50	33	50	6
Very High	15	7	0	33	0	0	0	6	0	12	0	0	11	0