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Strengthening drinking water security through development of climate resilient water safety plan for urban water supply system of Bangladesh

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Abstract

Safe drinking water is a fundamental need for human development, health and well-being, and it is an internationally accepted human right. In recent decades, extreme hydroclimatic events and their changeability have been posing significant threats to the water supply system, especially in the coastal cities. The aim of this research was to strengthen drinking water security through the development of climate resilient water safety plan (CRWSP) for a typical coastal municipal area of Bangladesh. The methodological stages of the water safety plan established by the World Health Organization (WHO) were followed to carry out this study based on both qualitative and quantitative data. The findings revealed that about three-fourths of the respondents are satisfied with the existing water supply system of the municipal area though the dweller's trust on water quality is found to be low, while very few percentages of the respondents drink the supply water due to microbial contamination. The hydroclimatic events including excessive rainfalls, cyclones, and sometimes inundation due to river floods allow the contaminated water to enter into the pipeline when there is no pressure. The study found that the existing technologies become non-functional and the water quality mainly deteriorates during the pre-monsoon period owing to extreme hydroclimatic events, whereas the distribution line and household/commercial connections are subjected to very high risks. The study identified the hazardous events that may compromise the effectiveness of the CRWSP. The anticipated risks of hydroclimatic hazards and/or extreme weather events can be reduced by improving the operational practices maintained by the professionals and personnel of the urban water supply scheme. The study concluded that the CRWSP is an important tool for strengthening drinking water security for water service providers by improving their administrative, financial, organizational, and operational plans.

Significance of the research

- The traditional approach to water quality and safety management has relied on the testing of drinking water. Through, only water quality testing it was difficult to identify the major risks of a supply system.
- Normal water safety plan considered only environmental hazards when it is implemented.
- In this context, the World Health Organization brings a new “Climate Resilient Water Safety Plan” concept for safe drinking water management from source to consumer.
- But in the context of Bangladesh, no research works have been done for the development and implementation of water safety plan considering climate risks of the particular places.
- Proper development and implementation of climate resilient water safety plan can minimize such risks including the future risks considering climate change, its variability, and climate extreme events, and thus ensure drinking water safety and security.

Methodology

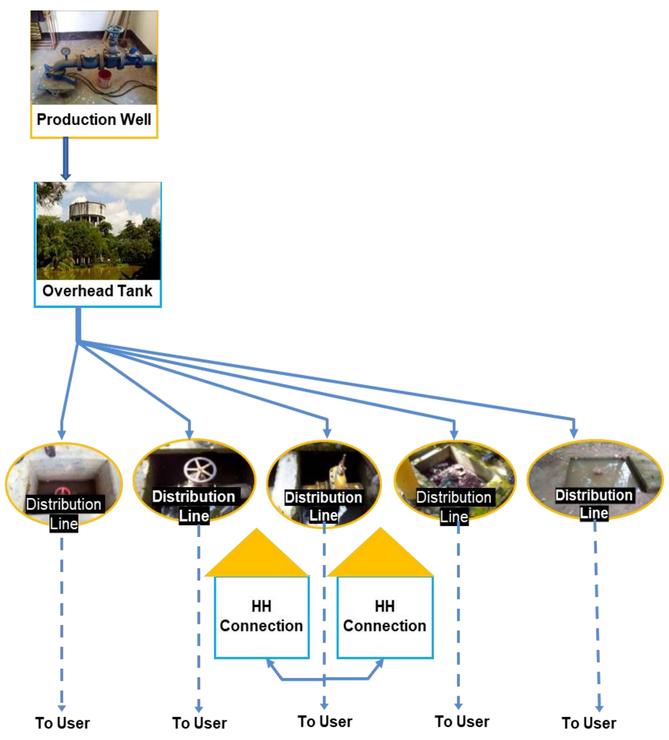

Figure 1. Flow diagram of Kalapara Municipality water supply system

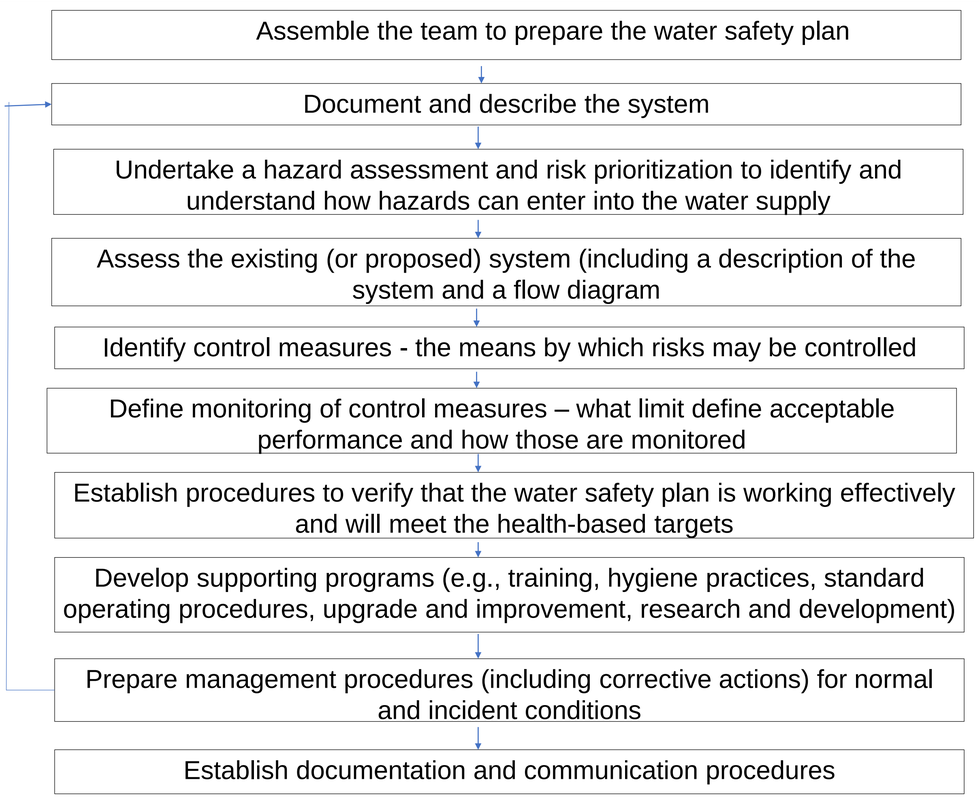

Figure 2. Climate-resilient water safety plan development process

Severity and Likelihood Matrix	Severity				
	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Likelihood: Almost certain (5)	5	10	15	20	25
Likely (4)	4	8	12	16	20
Possible (3)	3	6	9	12	15
Unlikely(2)	2	4	6	8	10
Rare (1)	1	2	3	4	5

Risk Rating: Low (L ≤ 5) | Medium (M 06-14) | High (H ≥ 14)

Figure 3. The likelihood and severity matrix of risk assessment

Results and discussion

Table 1. Identified problems in the water supply system

Step of Water Supply System	Present Problem
Source of Water	Water does not meet the demand in some parts of the supply system.
Source Water Quality	Yellowish Color
Water Treatment Process	No treatment process exists
Reservoir	No reservoir exists
Distribution Line	Presence of garbage and stagnant wastewater in the sluice valve chamber in different location. Iron deposition inside the pipelines has reduced the effective diameter of pipelines. Leakages exist in the pipe network. The wash-outs are in vulnerable condition due to lack of pressure, wash out cannot be performed properly. The street hydrant management at the community level is poor.
Water supply connection	The area is low lying and the waste and fecal sludge management is not good. Erratic heavy rainfall inundated the user connection for number of days which allows the contaminated water to entry into the pipeline when there is no pressure.
Distributed Water Quality	Presence of high fecal contamination and significant existing of nitrate.

No	Seasons	Months	Impact of climate risks on water supply			
			Existing technologies become non-functional	Colleting water from long distance	Getting quantity of water	water quality is decreasing
1	Winter	DJF	5	3	4	9
2	Pre-Monsoon	MAM	26	4	7	45
3	Monsoon	JJAS	7	0	0	3
4	Post-Monsoon	ON	1	1	0	5

Table 2. Hazardous events, control measures risk associated at different steps of the water supply system

Step	Hazardous Event	Hazard type	Risk (without control) L = likelihood S = severity R = risk score	Risk with climate factors L = likelihood S = severity R = risk score	Existing Control Measures/ preventive action/ barriers	Is the existing control measure effective? Y = yes, N = no U = uncertain N/A: Not applicable	Required Corrective Action	Risk after Corrective Actions L = likelihood S = severity R = risk score	Improvement Action Plan
S	Scarcity of water in source (groundwater) due to depletion of water table in dry season	Physical	L: 3 S: 2 R: 6 (Medium)	L: 4 S: 4 R: 16 (High)	No control measure existing	N/A	The surface water-based treatment plant should be installed	L: 1 S: 3 R: 3 (Low)	Explore the deep aquifer by suing Rigs
PTW	Less production of water at PTW due to reduced pumping efficiency caused by the inefficient placement of filter	Physical	L: 2 S: 3 R: 6 (Medium)		No control measure existing	N/A	N/A	L: 2 S: 3 R: 6 (Medium)	Selection of appropriate depth of for placing the screen
PTW	Contamination of groundwater at source (PTW) due to ineffective sanitary seal in pump house	Physical, Microbial	L: 2 S: 2 R: 4 (Low)		Sanitary seal exists	Yes	N/A	L: 2 S: 2 R: 4 (Low)	N/A
DL	Contamination of water in the pipeline due to leakage and increased temperature will enhance the fecal contamination then the normal in the distribution line	Biological	L: 4 S: 4 R: 16 (High)	L: 5 S: 4 R: 20 (High)	Regular repair	Yes	The quality of material used for repairing the distribution network need to be ensured	L: 1 S: 4 R: 4 (Low)	N/A
DL	Water stagnation due to flooding, tidal surge and heavy rainfall will increase the contamination of water at sluice valve chamber due to intrusion of contaminated water and agrochemicals through the leakage in gland packing	Physical Biological	L: 4 S: 3 R: 12 (Medium)		No	N/A	Cleaning of sluice valve chamber at a regular basis	L: 3 S: 3 R: 9 (Medium)	Repair the sluice valve chamber with cover and fill the sluice valve chamber with sand
HH/CC	Contamination of water due to leakage in house connection pipe when pipe line is exposed to waste water drain and increased temperature will create a more favourable condition for further water quality deterioration.	Physical, Microbial	L: 3 S: 5 R: 15 (High)		No control measure	N/A	Use pipe casing if pipe line goes through drain, and raise pipe line above drain height.	L: 1 S: 5 R: 5 (Low)	N/A
HH/CC	Contamination of water during collection at households due to unhygienic condition near water collection tap and platform. Erratic rainfall, water stagnation will further degrade the quality of the supplied water	Physical, Microbial	L: 2 S: 5 R: 10 (Medium)		PWSS staff encourages consumers to maintain hygiene	U	PWSS staff, through Mayor notice, will command all consumers to maintain hygiene and construct platform at collection point	L: 1 S: 5 R: 5 (Low)	N/A
HH/CC	Increased temperature will create a more favourable condition for faecal coliform to increase its concentration in underground and overhead tank water	Physical, Microbial	L: 2 S: 5 R: 10 (Medium)		Consumers clean the tank when they think it is necessary	U	PWSS staff, through Mayor notice, will command all consumers to clean their underground and OHT regularly	L: 1 S: 5 R: 5 (Low)	N/A

Conclusion

- The distribution line and household/commercial connections showed very high risks.
- The study demonstrated that the hazardous events that may compromise the effectiveness of the CRWSP.
- Successful implementation of climate resilient water safety plan considering the climatic and environmental hazards can provide the best solution for safe drinking water management.

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