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Promoting Rainfed Pond for Town's Water Supply System: A Case Study of Southwest Coastal Region in Bangladesh

[1] Md. Zahid Hossain, [2] Dr. Ghulam Murtaza

[1] Technical Consultant (Bangladesh Rural Water Supply, Sanitation and Hygiene for Human Capital Development Project of Bangladesh Government), Palli Karma-Sahayak Foundation (Government Organization), Bangladesh

[2] Ex. Professor, Urban and Rural Planning, Khulna University, Bangladesh

Corresponding Author: **Md. Zahid Hossain**

Abstract

Bangladesh coastal area is vulnerable to the changing climatic condition because of its geographic location and low-lying topography, and this vulnerability has been acute due to reducing upland flow during dry period and sea level rise contributing to saline intrusion and inundation of coastal freshwater resources. Over the past 25 years, salinity intrusion in Bangladesh has increased by about 26 percent with the affected areas expanding each year. According to a study by World Bank on 2014, climate change is likely to further increase river and groundwater salinity dramatically by 2050 and exacerbate shortages of drinking water in the southwest coastal areas.

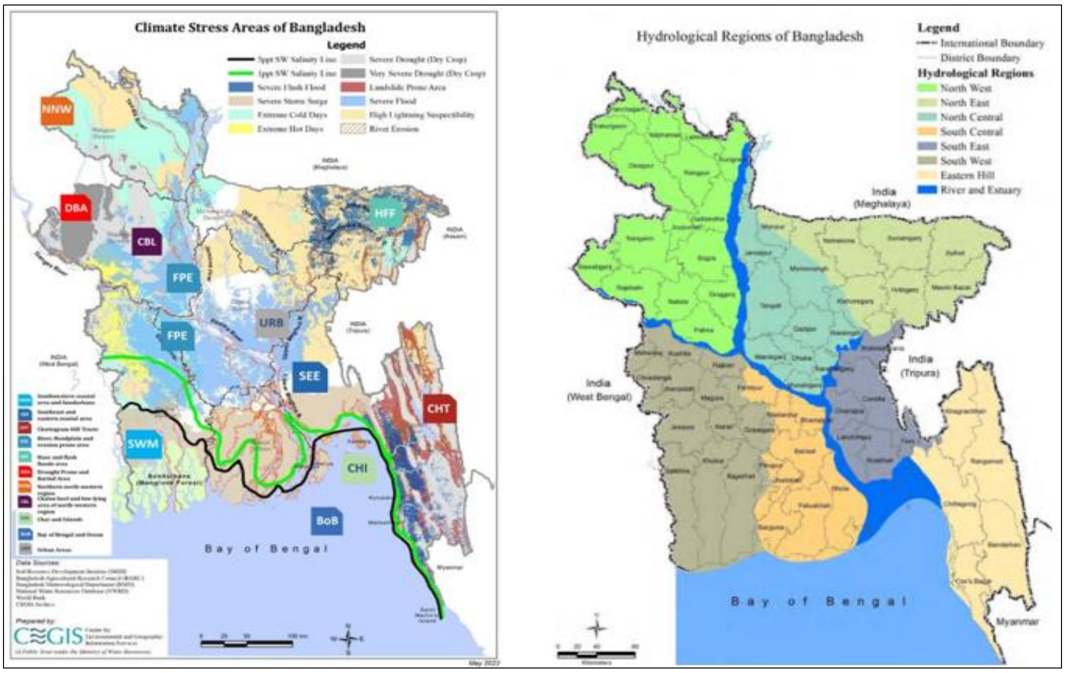
Because of salinity of both groundwater and surface water in the Mongla port municipality area, compound river water and rainfed pond water became the main source of drinking water here. Currently, Mongla port municipality located at coastal belt is supplying water to town dwellers by pipeline with water treatment system taking raw water from both harvested rainwater and limited period of river water through pond.

From physical observation, focus group discussion with water users and interaction with key information providers, study team assessed the quantity of water against the demand and also analysised the quality of water both are satisfied. By using secondary data, study team also analyzed the Mongla river's water salinity and rainfall intensity for assessing the long run feasibility of it. Result of the study on Mongla port municipality's water supply shows that it is well functionable system, could be replicated to another coastal area as it is nature-based solution which makes the people and authority to adapt it easily with keeping well-functioning.

Keywords: Rainfed Pond, Water Supply, Salinity in Coastal Area, Climate Change, Nature-Based Solution

1. Introduction

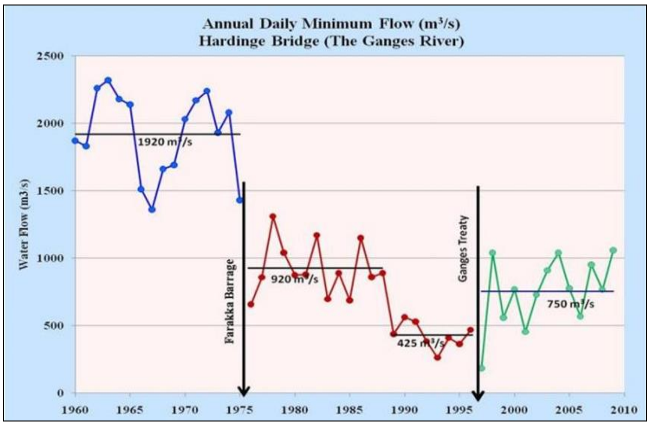
The coastal zone of Bangladesh covers one third of whole areas population nearly 40 million. Out of 64, 19 districts are coastal, the most southwestern five coastal districts, i.e., Satkhira, Khulna, Bagerhat, Pirojpur, and Barguna, have been identified as the hard-to-reach areas. People in these districts have been exposed to different types of water security risks, particularly groundwater contaminated with salinity, which is not suitable for human consumption. Previous studies conducted by many research organizations have consistently reported higher salinity, as well as considerable trace and toxic elements in the groundwater samples from this area. Hoque (2009) estimated that approximately 30 million people are unable to collect potable water and 15 million people are already forced to drink saline groundwater in this region. This is principally due to the higher degree of spatial variability of salinity in both shallow and deeper aquifers. It is a consequence of the complex coastal hydrogeology and land use of the active Ganges–Brahmaputra delta. This water quality constraint, together with complex hydrogeology, leads to the unavailability of suitable freshwater aquifer layers limiting the use of tube wells. Therefore, coastal people of southwest Bangladesh have to rely on alternative options. In these five coastal districts, 12–34% of the inhabitants are using alternative sources such as rainwater, surface water, and other unimproved water sources.



Map 1

Climate Impact Stress of Southwest Region

Southwest (SW) region is vulnerable comparatively others 7 hydrological regions because of salinity intrusion is high here. Green and black lines of the map (left side) show the salinity concentration 1 ppt and 5 ppt respectively which covered almost all areas of SW region. Three mighty rivers Ganges (in Bangladesh is called Padma), Brahmaputra, Meghna's water follow is being the caused to create salinity variation in south coastal zone in Bangladesh. SW region's salinity intrusion is high because of Padma's branch river Garai and Modhumoti are being dried up due to low water flow during dry season caused by climate change and withdrawing river water from up land. However, salinity intrusion in South-centre and Southeast regions are comparatively low because of up surface flow comes from jointly three mighty rivers-Padma, Brahmaputra and Meghna, that's why here back flow from Bay of Bengal is less than back flow in SW region. Intrusion of back flow from sea depends on river flow, that why study team analysied the Ganges minimum water flow for having the understanding about salinity intrusion in SW region.



Graph 1

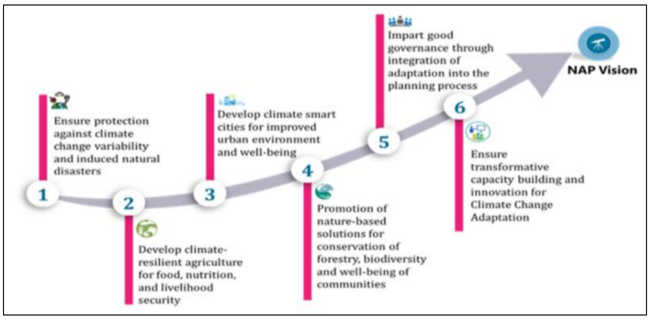
Above Graph 1 on annual daily minimum flow (m^3/s) of Ganges water at Hardinge Bridge is taken from a study 'River salinity and climate change' carried out by the World Bank on 2014. This Graph 1 shows that before Farakka Barrage minimum water flow of Ganges to Padma River was 1920 m^3/s, but after Farakka Barrage it had started to reduced and reached at minimum average flow at 425 m^3/s on 1990. After the Ganges water treaty on 1996, minimum average water flow started to move up at 750 m^3/s

2. Review of Literatures, Country's Strategy, Policy and Act

Many literatures have been taken to review with a view to gathering the information about on rainfall pattern and intensity. The rainfall patterns in Bangladesh are governed by seasonally varying meteorological system of south-west monsoon, in where monsoon and winter seasons are separated by two transitional seasons namely pre-monsoon and post-monsoon (Quadir *et al.*, 2006) [5]. Several studies (Choudhury *et al*., 1997; Quadir *et al.*, 2001) have reported that the precipitation in Bangladesh has been increasing during the recent decades. Hussain *et al*. (2001) found that the mean annual rainfall was 2387.20 mm from 1975 to 1995. May to September were the highest rainfall months when the rainfall was more than 300 mm in over 63.80 % of the years. Karmakar and Mian (1994) stated, the correlation between pre-monsoon rainfall and monsoon rainfall over different station of Bangladesh According to Ahmed and Karmakar (1993). Chowdhury and Debsarma (1992) investigated a significant upward trend of precipitation (by 18%) in the north, west south-west 11 region since the early 70%, and a downward trend in the south-east. Quadir *et al.* (2003) reported that the average annual over Bangladesh varies from 1429-4338 mm. About 75% of the annual precipitation occurred during the monsoon period, about 15% in the pre-monsoon season and the rest 10% occurred in winter and post-monsoon season. In Bangladesh monsoon, average rainfall varies from 1194 mm to 3454 mm (BBS, 2002). More than 70% of Bangladesh annual rainfall occurs in the monsoon (June-September) season (Hussain and Sultana, 1996 [9]; Matsumoto, 1998). The main rainfall during the monsoon season ranges from 1000 to

3000 mm in the country. The annual rainfall in the country ranges from 1400 to 5800 mm, but its distribution is uneven. Country's strategy, 8th Fiver Year plan has been reviewed. Country's policy regarding water policy, water supply and sanitation policy, national arsenic mitigation policy, climate change strategy, national adaptation plan, coastal zone policy, water act, water rules along with country's 8th Five Year Plan (FYP) were reviewed.

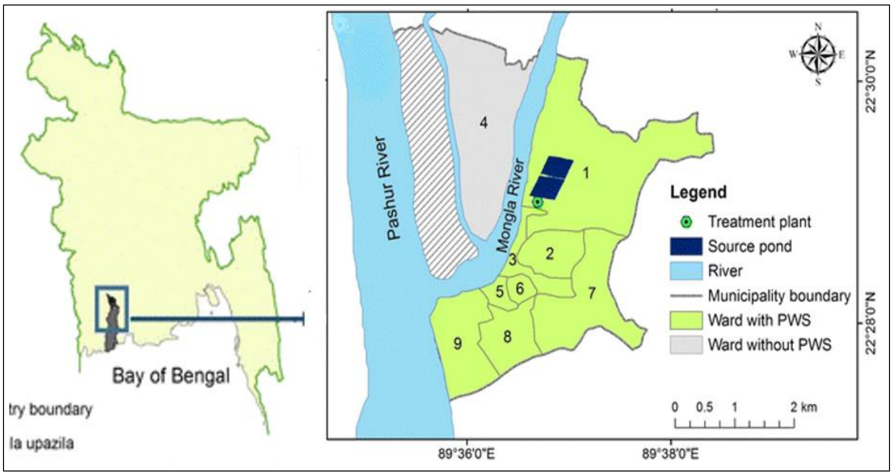
According to National adaptation plan formulated on 2023 shows that nature-based solution is best way for adaptation. Rainfed pond is being an option as water supply for coastal area in Bangladesh where water scarcity is acute. Water act and water rules has been giving support for restoring the ponds for drinking purpose and giving security anyway these ponds could not be used for other purposes instead of drinking water. 8th FYP has been focusing to digging rainfed pond for ensuring safe water for people in coastal area specially at SW region. National water policy and national water supply and sanitation policy have been inspiring to adapt rainwater harvesting where possible. Coastal Zone policy and Climate change strategy also giving importance to rainwater harvesting for drinking purposes at coastal area in Bangladesh.



Graph 2

3. Study Area

Mongla port municipality is situated under Bagerhat district in the southwest coastal region in Bangladesh. This municipality was established in 1990 and became 'A' class municipality in 2012. The municipality has 8615 Holding Number where 2980 HHs are connected with pipeline water supply. The literacy rate among the town's people is 53.6%.

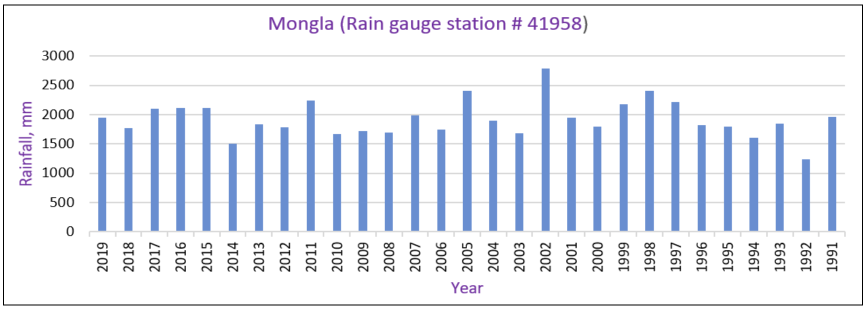


Map 2

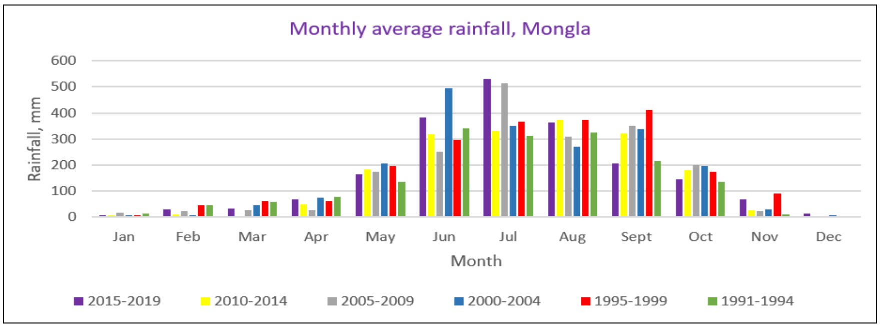
4. Discussion and Result Analysis

4.1 Rainfall Intensity of the study area

Availability of rainfall data, rain curve in hydrological map of country and 41958 # rain gauge is the best for choosing as it is situated at Mongla. Data collected from Bangladesh Agricultural Research Council (BARC)' webpage. Monthly and yearly rainfall from 1991 to 2019 has been analyzed, Table for yearly rainfall in Mongla from 1919 to 2019 showed not continuously degradation or upgradation but showed a fluctuation which did not follow a time interval. After analysed, it was seen, yearly rainfall was unpredictable from 1991 to 2019. As example, in 1992 annual rainfall was 1232 mm, and next year in 1993 it was 1853 mm, and previous year in 1991 it was 1997 mm, means that there was a huge gap in consecutive two years. In addition, after 10 years it was 2786 mm in 2002. On the other hand, another observation was founded, in 2017 annual rainfall was 2100 mm, and since then it was around 2000 mm with fluctuation. Rainfall intensity lowest to highest was 1258 mm to 2786 mm respectively, but we can assume an average rainfall in Mongla is 1800 mm based on analysed and correlation with literature.



Graph 3



Graph 4

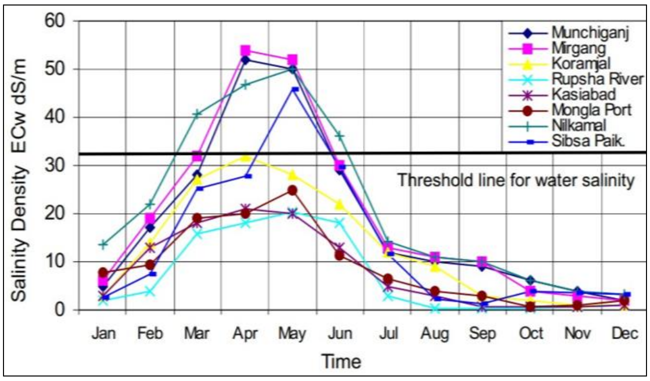
From 1991 to 2019, monthly rainfall showed that there was a fluctuation in their intensity, but maximum rainfall has been happening from June to July. Monthly rainfall also shows significant rainfall has been happening from May to October. During of rainfall is being shorten than earlier decade.

From analyzing the monthly rainfall from 1991 to 2019, study team assume the monthly rainfall is in below table for calculating the effective harvested rainwater for Mongla port municipality.

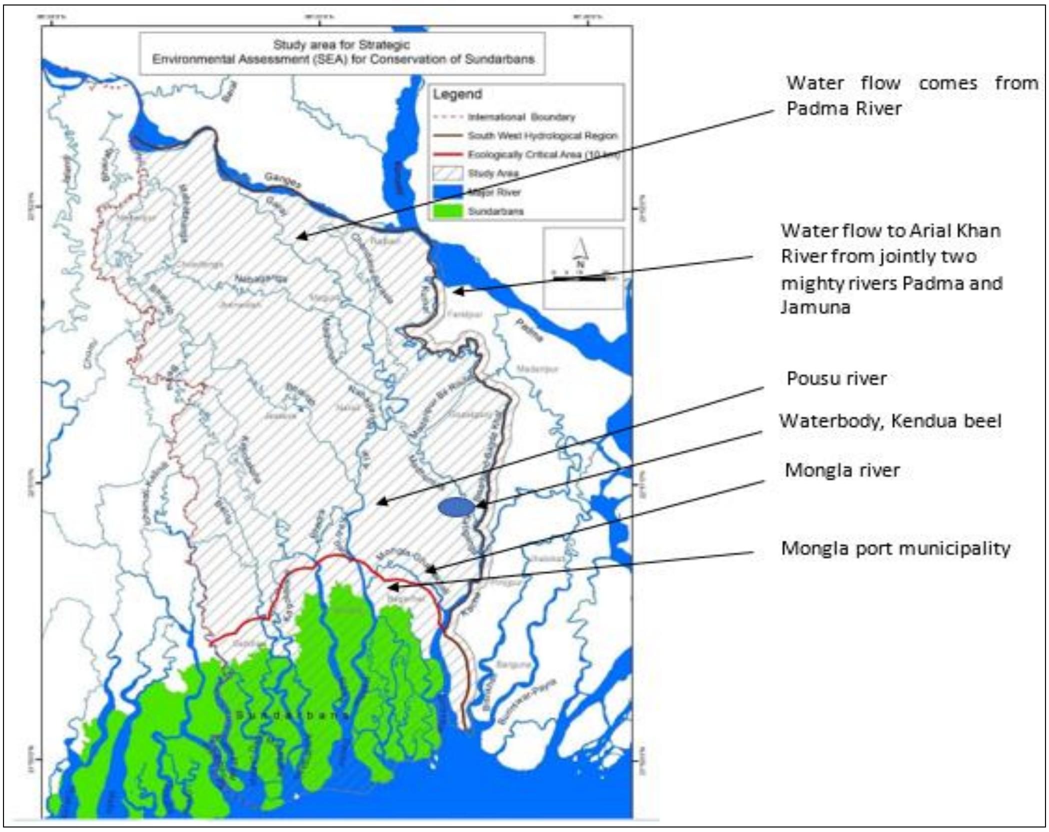
Name of month	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Rainfall, mm	0	0	0	70	150	300	320	270	160	120	0	0

4.2 River's Water Quality

Using secondary data from Bangladesh Water Development Board and published journals following map was analyzed for getting the understanding of river water's salinity at the Mongla port. The river's water at Mongla port from where water has been collecting for Mongla municipality is September to December as salinity level during that period is 0.25 to 0.30 dS/m. During interaction with concern persons of Mongla port municipality and physical observation of water collecting practice it was seen that Mongla port municipality is collecting river's water from September to Mid of January every year.



Graph 5

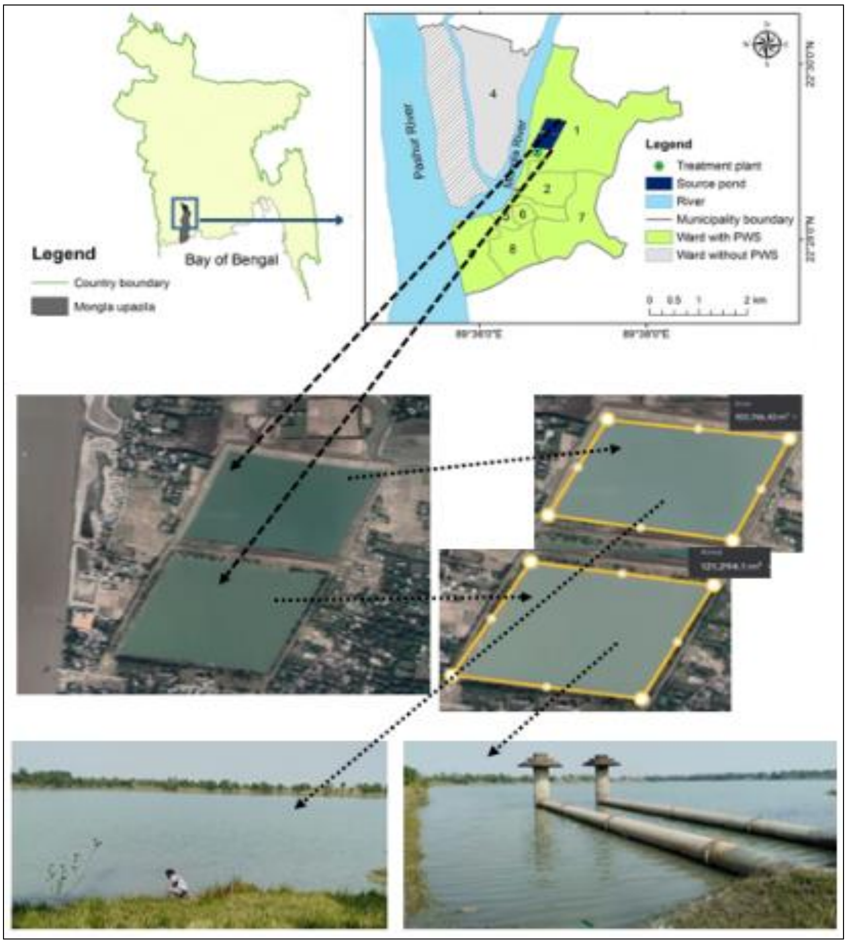


Map 3

Above map-river basin was analysed for why Mongla river's water is acceptable salinity for drinking purposes from September to December than Pousu river. Mongla river's water comes from multiple water bodies, one of them is Kendual beel. Basically, Arial khan river originated from two mighty rivers- Padma and Jamuna has been contribute its flow to branches river from which Mongla river originated. River morphology of Mongla river makes it for comparatively less senility than Pousu.

4.3 Calculation of Pond's Water Capacity

Rainfed pond's catchment area was analyzed physically, interaction with municipality and google map has been showed as in below map and pictures.



Pictures 1

Total catchment area of the ponds is 224,040 square meters. And average depth is 1.5 meters. Total volume of pond is 336060 m^3

4.4 Water demand VS Supplying

Pond's volume is 336060 m^3. Currently 2980 Households and 220 establishments are connected with pipeline water supply system. So, current monthly water demand 61500 m^3 considering 2980 HHs and 220 establishments.

Month	Current Water Demand (m^3)	Harvested Rainwater (m^3)	River's Water (m^3)	Cumulative Water (m^3) After Monthly Consumption
January	61500	0	0	268,500
February	61500	0	0	207,000
March	61500	0	0	145,500
April	61500	15,680	0	99,680
May	61500	33,600	0	71,780
June	61500	67,200	0	77,480
July	61500	71,680	0	87,660
August	61500	60,480	0	86,640
September	61500	35,840	150,000	124,340
October	61500	26,880	364,620	330,000
November	61500	0	61,500	330000
December	61500	0	61,500	330000

4.5 Water Quality

For getting the understanding about water quality, study team analysed the water quality data tested by Mongla Port municipality and discussed with users at different levels such as Riksha Van pullers, labours, teachers, shopkeepers, house owners especially female. During interaction study team asked them is its sweet water? how much salinity they feel during drinking and when it increases? Did you get smell? Are they satisfying with this water. Most answers where salinity is acceptable, but 15% said during dry season salinity is high but drinkable. No smell they found but sometimes get more turbidity said 25% responded. Municipality's water data showed that salinity range is 600 mg/l to 850 mg/l.

Study team observed and analysed the treatment facility, about baffle filter with alum dosing aiming to get turbidity below 5 NTU, sand filtration and chlorination system and testing data of residual chlorination at end point of service which are almost okay.

But sometimes get more turbidity, users responded, because of poor operation like alum and chlorination dosing does not giving properly.

Pictures 2: Treatment facility

5. Conclusion

As study team found from the analytical results that Mongla river's water salinity is acceptable for four months from September to December which is not sufficient to meet the water demand all-round the year. In this case rainwater harvesting in pond when river water is not available, giving support to addressing the water demand all-round the year. In addition, from April to August, water is sweeter than other months as rainwater reducing the concentration of salinity of pond water. So, from the facts and statistics of the result, this study is telling what technology is taken at Mongla port municipality for town's water supply system is sustainable due to adapting the nature-based solution. Therefore, this study has been evidenced to promote this nature-based technology at climate vulnerable coastal area where it is feasible.

6. References

1. M Shafi N, Albrecht Gnauck. Threats to the Sundarbans Mangrove Wetlands Ecosystems from Transboundary Water Allocation in the Ganges Basin: A Preliminary Problem Analysis. International Journal of Ecological Economics & Statistics. 2009; 13(9):64-78.
2. Md. Sabbir, Ali Islam, Kabir, Hoque. Monitoring bacterial Contamination of piped water supply in rural coastal Bangladesh. Environmental Monitoring and Assessment. 2017; 189:1-13.
3. Susmita, Kamal, Khan, Ainun Nishat. River salinity and climate change evidence from coastal Bangladesh; published by World Bank, In World Scientific Reference on Asia and the World Economy, 2014, 205-242.
4. Rainfall data from Bangladesh Agricultural Research Council.
5. Quadir DA. Climate variability of Bangladesh. Contribution to monsoon Asia Integrated Regional Study (MAIRS). SMRC, Dhaka, 2006.
6. Ahmed AU, Haque N. Climate Change and Sustainable Development. Paper presented at the Dhaka Meet on Sustainable Development, 2002, 14-18. Incorporated in Q.K. Ahmad and A.U. Ahmed (eds.), Citizens' Perspectives on Sustainable Development, 2002.
7. Md Zahid Hossain, Imrul Kayes Muniruzzaman, Hasin Jahan. Prospect of Rainwater Harvesting in RMG and Textile Industry: Lessons Learned From 4 Factories in Bangladesh.
8. Ali MM, Ahmed M, Talukder MSU, Hye MA. Rainfall distribution and agricultural Droughts influencing cropping pattern at Mymensingh region. Progressive Agriculture. 1994; 5:197-204.
9. Hussain MA, Sultana N. Rainfall distribution over Bangladesh stations during the monsoon months in the absence of depression and cyclonic stoilils. Mausam. 1996; 47:p33.
10. Bangladesh 8th FYP, National water policy, National water supply and sanitation policy, Coastal zone policy, Climate change strategy and action plan, National adaption plan, Water act and Water rules.
11. Groundwater Zoning map-2004 and 2010 developed by Agricultural Development Corporation.