EXISTING WATER QUALITY SCENARIO OF MIRPUR WATER SUPPLY AND DISTRIBUTION NETWORK, NORTH DHAKA CITY CORPORATION, BANGLADESH

Rumman Mawla Chowdhury[1], Adib Ashhab Ankon[*1] and Jahidul Alam[1]

[1] *Assistant Professor, University of Asia Pacific, Dhaka, Bangladesh, e-mail: rumman@uap-bd.edu*
[1*] *Graduate Student, University of Asia Pacific, Dhaka, Bangladesh, e-mail: adibankon50@gmail.com*
[1] *Graduate Student, University of Asia Pacific, Dhaka, Bangladesh, e-mail: jahidulalam150014@gmail.com*

***Corresponding Author**

ABSTRACT

The research was conducted to determine the overall quality of consumptive water consumed by households in North Dhaka. This was accomplished by collecting samples from 28 WASA connections throughout the Mirpur zonal region. Aside from WASA water, home tap water from various houses was gathered, as well as the water they use for drinking. The majority of the WASA connection samples yielded high-quality water in both the monsoon and pre-monsoon seasons. The WASA water sample and the House tap water sample did not differ significantly. This demonstrates how WASA drinking water is saved throughout the distribution network. Hardness and fecal coliform levels in household tap water have been determined to be within acceptable drinking water limits, using a filtering technique. Hardness and fecal coliform levels in household tap water were determined to be within acceptable limits. Furthermore, iron and total suspended particles were high in some of the sample places, although Mirpur's water quality is satisfactory when compared to a dense population and widespread lack of water health information.

Keywords: *WQI, WASA, Tape water, physio-chemical properties, Water purifying process, Drinking water.*

1. INTRODUCTION

Bangladesh is a third world Least Developed Country (LDC) where urbanization is outpacing population growth and agglomerations are quickly expanding. The negative effects of urbanization include the loss of agricultural land, challenges with urban food supply, habitat damage, and urban diseconomies (Simon, 2008).

Water is one of the most important components of human physiology, and man's continued life is strongly dependent on its availability. Water is considered a fundamental factor in life since a man can survive longer without food than he can without water (Gleick, 1998). The increasing human population has put a huge demand on the supply of safe drinking water, particularly in developing countries like Bangladesh. The water they drink is tainted in a few ways by harmful and damaging elements like pesticides, insect bites, and other things. Many consumers have also reported odour and hair loss because of the tainted water (Schweitzer & Noblet, 2018). Geological conditions, water treatment facilities, pipe leaks, and pipe corrosion can all lead to water pollution.

The World Health Organization (WHO) estimates that improved drinking water sources supply 89 percent of the world's population. Water quality must be assessed on a regular basis since the human population suffers from a range of waterborne illnesses as a result of drinking contaminated water (Onda, LoBuglio & Bartram, 2012). Based on public opinion surveys and laboratory test results, the BBC determined that the quality of drinking water in the Mirpur district is improving.

The main purpose of the study is to analyze the water collection and distribution systems on the ground and in residences in the MIRPUR district. The analysis will establish whether or not WASA's supply system requires improvement. Furthermore, efforts have been undertaken to educate the Dhaka City Corporation and WASA communities about the current situation of water supply networks. The goal of the study is to determine the differences in impurity removal performance across various water purifying systems, as well as to learn about the current Mirpur WASA connection status. This research can help determine the quality of the water.

Water samples were gathered from 28 different connections spread over the Mirpur zonal zone. WASA samples were examined for pH, DO, Color, Conductivity, TDS, TSS, Hardness, Turbidity, Fe, Fecal Coliform, E-coli, and Chlorine readings at the three sampling stations are high due to the use of disinfectants. The overall dissolved and suspended material levels in both supply and WASA water were high. The boiling method was shown to be the most successful in removing fecal coliform.

Mirpur is the biggest area in Dhaka and is home to around 10 million people (Weaver et al., (2019). There have been no additional investigations on the Mirpur water supply system or water quality. Despite the substantial investigation, the project faces major hurdles. Choosing the perfect pump for a certain site, for example, was a difficult process.

1.1 Current Water Demand and Production

DWASA estimates total water consumption at 150 liters per person per day and deliver water to city inhabitants accordingly. DWASA's capacity allows it to meet current water demand. DWASA, on the other hand, has never met its production objective and actual output for groundwater and surface water with a demand-supply mismatch. Furthermore, if we account for Unaccounted for Water (UFW) or system loss between production and end-user level, the true supply is 1426.18 MLD. According to the table 1, about half of Dhaka's population does not have access to the DWASA's estimated standard water need (150 l/p/d). Furthermore, there are 1330 and 1500 DTWs operated by private agencies and other unidentified sources.

Table 1: Water production scenario of DWASA.

MLD	Production Capacity	Actual Production	Source wise % of production	% of capacity	No. of DTWs and SWTP in operation
Groundwater	1948.30	1831.20	93.99	87.72	560
Surface water	299.17	256.30	85.67	12.28	4
Total	2283.47	2087.5	179.66	100	564

Source: Dhaka WASA.

1.2 Study area

Mirpur is the largest and most densely inhabited area in Dhaka. The management of WASA pumps and supply lines is a major concern in this area. This research will aid in improving maintenance quality and increasing consumer trust. It may also be determined if the water that people drink is safe to drink.

Table 2: WASA condition in the Mirpur area.

Total WASA pump no at whole Mirpur	Dual pump setup 20+Normal pump 97=117
Water Demand at Mirpur	27 crores liter/day
Source of water	90% groundwater and 10% surface water.
Source of surface water	Pagla water treatment plant at Sayed Abad
The purification process of water by WASA	Chlorination
the peak hour of water demand	morning (7.30-10.30) am, and night (6.30-9.00) pm
Running Pump condition	30% of pumps are running with the new setup, 70% of the pump are running with an old manual setup
Improvement process of WASA pumps	Ongoing

Source: Dhaka WASA, Mirpur Zone Office

The Mirpur Model Thana (Dhaka metropolitan) has an area of 58.66 square kilometers and is located between the latitudes of 23°46' and 23°48' north and the longitudes of 90°20' and 90°22' east. It is bounded on the north by Shah Ali and Pallabi thanas, on the south by Sher-e-Bangla and Darussalam thanas, and on the east by Pallabi and Kafrul thanas, with a total population of around 1,074,232. Mirpur Model Thana, located north of Bangladesh's capital Dhaka, was founded in 1962. North Dhaka City Corporation operates 38 WASA pumps, which serve as the sole source of water for over 6 million people. Every day, they use around 1000 c. liters of water.

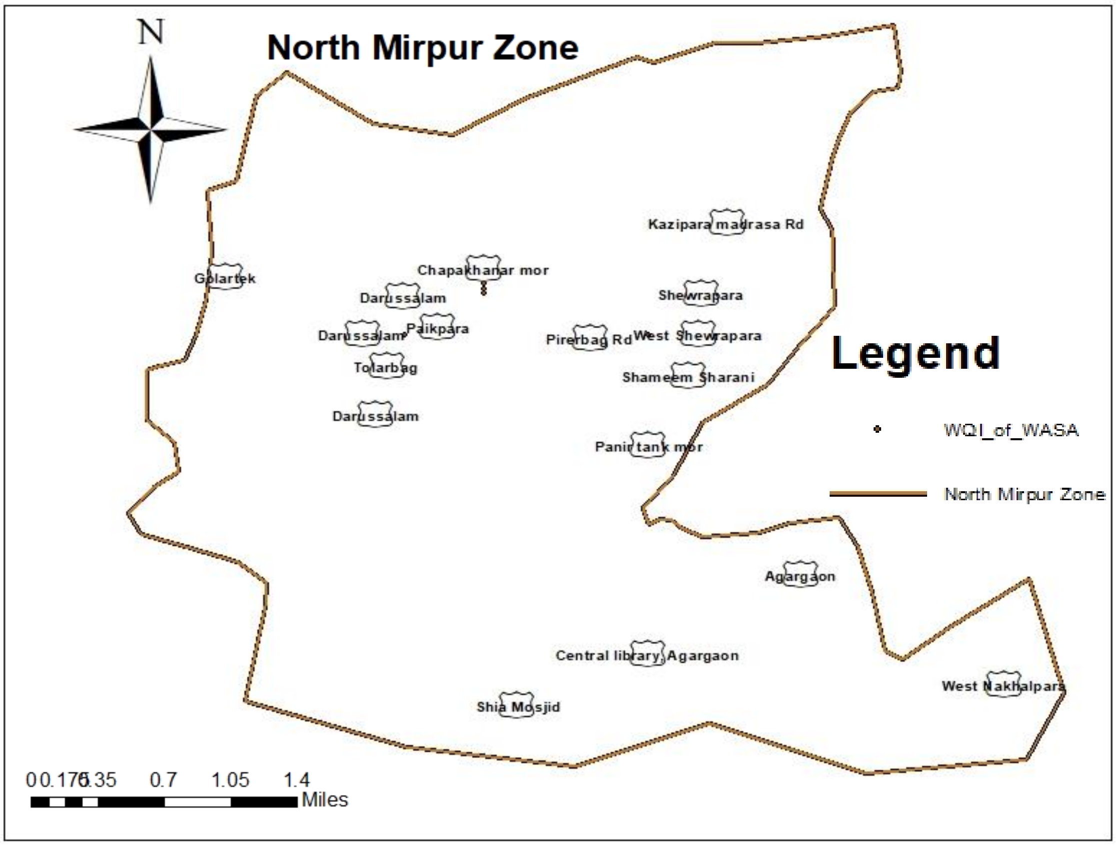

Figure 1: Study area and Sampling points in Mirpur.

1.3 Current situation of selected WASA pumps

Dhaka North City Corporation has about 38 WASA pumps. Around 6 million people are living there. They drink roughly 1000c.L of water every day. WASA is their sole supply of water. Pump lines carrying water are obstructed in several areas. Another issue in those pump lines is water leaking.

(a) (b)

Figure 2: (a) Water reservoir. (b) WASA water pump.

The WASA water reservoir in Figure 2 is not adequately maintained. There is waste here and there. The tank's lid is open. There is no pump schedule accessible there. The pump header is also broken. Bricks support the whole pump structure. There is a lack of upkeep here.

2. METHODOLOGY

The Mirpur water supply network map is used to collect drinking water samples in Mirpur. Initially, a field reconnaissance investigation was conducted, and sample stations were selected to cover the whole DWASA distribution network. For this reason, one-liter and 0.5-liter plastic bottles are used. They are thoroughly cleaned by rinsing them three to four times with sample water. The sampling vials are then filled to the full and promptly sealed to prevent air exposure. The samples are promptly transported to the Laboratory for further testing and analysis shown in the following flow chart (Figure 3). The water quality parameters are evaluated by comparing the test findings to both the Bangladesh Drinking Water Standard (BDS) and the WHO drinking water quality recommendations.

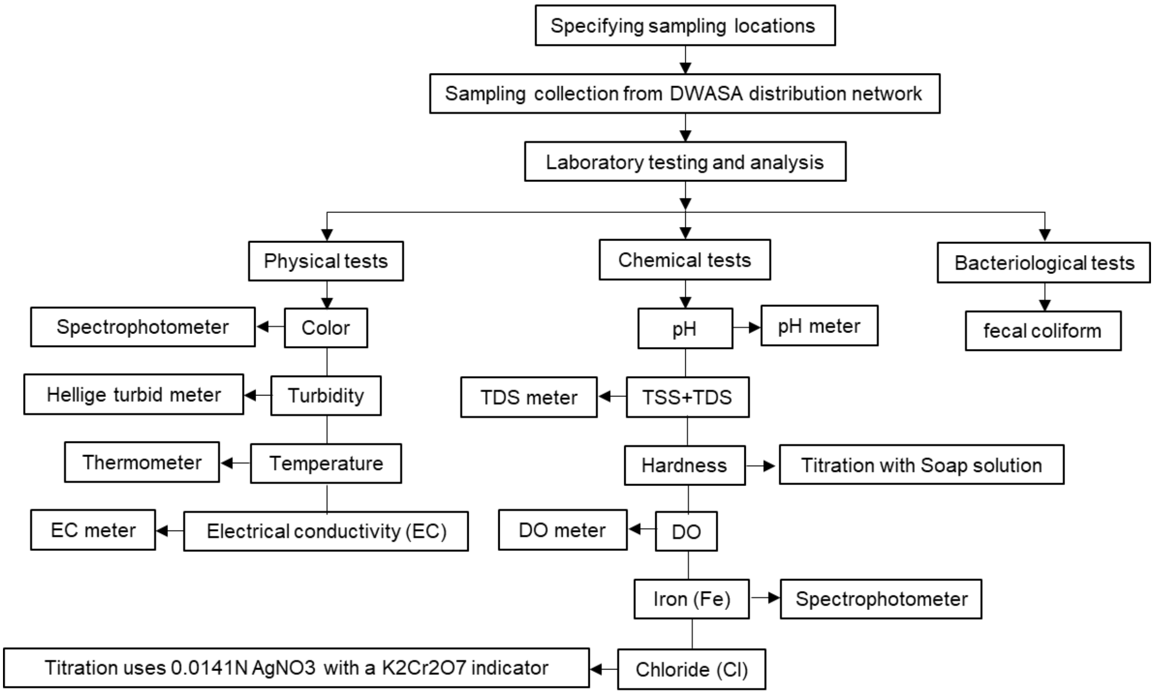

Figure 3: Methodological process of the study.

2.1 Collection of WASA information

WASA provided a wide range of data to analyze the overall status of the study area's water supply system. This information was collected directly from the WASA office, with some originating from an internet domain. Using WASA data to obtain critical information and pinpoint particular regions.

2.2 Questionnaire survey and Informal Interview

A questionnaire survey, informal interviews, and open discussions were conducted with the authorities of various concerned organizations, WASA, experts, and people living in the Mirpur study area (At 71 points withing the study area) to uncover the inherent problems of city dwellers caused by the Mirpur water supply system and its associated impact on local life. 79% of purchasers are unhappy with the stench of their home's tap water. Water might be coming from a defective tap or a damaged household supply line. Overall, 10% of consumers are pleased with the odor quality of their tap water, while 79% are dissatisfied.

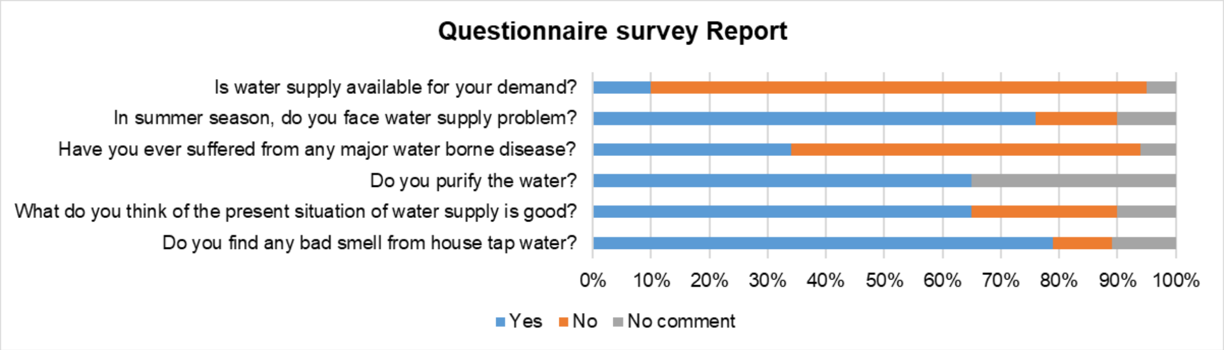

Figure 4: Questionnaire survey Report.

Although 65% of locals are satisfied with the quality of their water supply, 25% are dissatisfied with the amount. 10% of those questioned did not reply to this question. The amount of water available at the tap is determined by the size of the reservoir and its supply line.

Mirpur has a large number of uneducated residents. Because of their illiteracy, their income is restricted to 5000 Tk. 35% of people are not aware of any form of filtering system. Many people are unaware that boiling is a method of purification. 65% of respondents used a known purification process to purify their water.

Water-borne infections such as cholera, typhoid, jaundice, and others have affected 34% of the population. These illnesses can be found in residential tap water due to the high percentage of fecal coliform. The remaining 60% of people had no significant ailments.

During the summer, WASA provides less water to people because they use more water and the groundwater table decreases. The problem impacted 76% of people, although 14% had no issues because there were fewer people in the family. Water is limited throughout the summer because WASA must repair water pipes on a regular basis.

Mirpur's fast-growing population drives up demand for WASA water on a regular basis. Because of their old equipment and pump, they are unable to satisfy demand. The pressure in the supply pipes is not distributed evenly. According to demand, supply is inaccessible to 85% of people. Only 10% of residents were satisfied with their water supply.

3. DATA ANALYSIS AND RESULT

All the collected data from the lab test and questionnaire survey both have been analyzed by using some statistical computer software and the analyzed data have been compacted.

3.1 pH

The World Health Organization (WHO) recommends a pH range of 6.5 to 8.5 (Rules, 1997). In that graph, the pH value of the supply and WASA water are the same. Some changes have been seen; however, the most significant modification was observed in Sample No. 3. (House tap water). That sample's pH was too low. It was discovered that there was an issue in that supply network. Otherwise, all of the sample results were satisfactory. The highest pH value in the graph (In Figure-5) is for drinking water sample 4. The sample of supply water has the lowest value. 3. Because of photosynthesis and respiration in the water, pH levels can change regularly. The degree of change is determined by the alkalinity of the water. Carbon dioxide is the most prevalent source of acidity in water.

3.2 DO (Dissolved Oxygen)

The dissolved oxygen standard ranges from 5-7 mg/l (Rules, 1997). DO has a significant shift on that graph (In Figure-5). This modification is not limited to a single supply of water. Every source of water gets a chance now and then. In brief, every sample of water is altered. Every change has a compelling cause. Temperature is the reason. Our sample is kept in our laboratory freezer. As a result, this type of alteration occurred. WASA sample 10 had the highest DO value of 9.56 mg/l. The lowest value, supply point 17, is 2.49 mg/l.

3.3 Color

The color standard recommended by the WHO is 15 Pt-Co (Rules, 1997). WASA water has a brighter hue than drinking and household tap water in that sample graph (In Figure-5). Some soil particles are undoubtedly present due to the depth of the WASA pump. And those particles produced that type of outcome in the color test. The hue of the other two samples is insignificant without the WASA water. The lowest color value in WASA sample 9 is 61 Pt-Co. The lowest result for various samples is 0 Pt-Co. Color increases as contaminants rise. Suspended particles in bodies of water can be the consequence of both natural and human activities.

3.4 Conductivity

In the sample graph (In Figure-5), we can observe that house tap water is more conducted than drinking and WASA water. The major cause of undesired conducted water is poor maintenance of the supply pipe network and an unlawful line of house tap water network. Samples 7 and 8 of our water sample are highly conducted. The WHO conductivity standard is 300 µ/c. The highest conductivity value for tap point 8 is 602 µ/c. In sample 17, the lowest conductivity value is 0 µ/c. The conductivity of water fluctuates as the concentration of ions in the water changes. The higher the ion concentration in water, the higher its conductivity. The conductivity of water is also affected by the sort of things dissolved in it. One factor might be the temperature of the water.

3.5 TDS (Total Dissolved Solids)

The WHO standard for total dissolved solids in water is 1000 mg/L (Rules, 1997). In WASA sample 8, the maximum TDS value is 290 Mg/L. The lowest TDS value is 116.3 Mg/L, which is found at drinking point 7. The TDS of WASA and home tap water are greater than the TDS of drinking water in the sample graph (In Figure-5). Because drinking water is purified using boiling or a water filtration filter. However, the material is dissolved in WASA water and travels through the supply network. Because of inadequate supply line maintenance, the amount of solid in the supply line might sometimes grow. That is the case in our example graph.

Figure 5: Variation of water quality parameters in Drinking water, Supply Tap, and WASA water.

3.6 TSS (Total Suspended Solid)

WHO recommends a TSS of 50 mg/L (Rules, 1997). The highest TSS value in drinking water point 15 is 29 Mg/L. Several lowest points are 0 Mg/L. The TSS of WASA water is somewhat higher than that of house tap water and drinking water in that sample water graph (In Figure-5). We can overcome this issue with good guidance and maintenance. However, a worse situation was generated with drinking water sample 15. The level of TSS is more than its range. Certain particles are present, and the water they drink is genuinely harmful. Impurities in the supply line can affect TSS. This might arise due to a lack of upkeep. Temperature can also affect the readings. The more contaminants in the line, the higher the TSS value.

3.7 Hardness

According to WHO, the maximum hardness value is 500 mg/l (Rules, 1997). The greatest value of hardness in the graph (In Figure-5) is 181 mg/l for sample 3 in the WASA point. The quantity of dissolved calcium and magnesium in water is the simplest definition of water hardness. Hard water contains a high concentration of dissolved minerals, including calcium and magnesium. In the sample water graph, we can see that the hardness of WASA water is fairly high at one point. The major reason for the undesirable consequence is poor pump filtration maintenance. Without it, all of the sample water results are moderate to good.

3.8 Chlorine

According to much research, drinking chlorinated water for an extended period may raise the risk of asthmatic episodes. Chlorine is a very effective disinfectant that is added to the public water supply system to destroy disease-causing organisms such as bacteria, viruses, protozoans, and many more. It may be extracted from water by heating it. However, we notice a wider range of cl in our example graph (In Figure-5). This might occur as a result of inadequate maintenance of the WASA system and the residential tap water system. And a home hole does not remove that much. The WHO standard for chlorine is 1000 mg/l (Rules, 1997). The maximum value of chlorine is 246.25mg/l for drinking sample point 4 and the lowest value is 0 for the majority of the samples.

3.9 Turbidity

According to WHO, the maximum turbidity value is 5 ftu. WASA sample point 9 has a maximum turbidity of 13 ftu. For the vast majority of the sample points, the lowest is 0. Water can become murky due to fine dirt and natural particles. However, the fundamental cause for this is the fine soil particle. We can observe from the sample graph (In Figure-5) that our WASA sample is significantly turbid than the others. The major reason for this is an elevated water table or aquifer. WASA suck pump their water from the top water layer in the high pick of the graph. So, this is what occurred. In the other sample, the turbidity level is moderate.

3.10 Alkalinity

If any modifications are made to the water that may cause the pH values to rise or fall, alkalinity functions as a buffer, buffering the water and its inhabitants from the abrupt changes in pH. The pH of alkaline water is greater than that of conventional drinking water. The pH of alkaline water is usually 8 or higher. When the salt content of water rises, the water becomes alkaline. A dramatic increase in salt content is discovered in our drinking water sample. As a result, the water sample becomes alkaline. The WHO guideline for alkalinity is 100 mg/l. The highest amount of alkalinity in the graph (In Figure-5) is 125.2 mg/l in drinking water sample no 8. The lowest value is 40.56 mg/l in drinking water sample no. 5. Other samples are mostly in the middle or somewhat above the average.

3.11 Fe

In Bangladesh, iron is a widespread issue. Water supply, and water table, even though the aquifer is rich in Fe (Iron). This problem may be negotiable if a deep well is constructed, and water is extracted from a deep aquifer. WASA water in our sample had a high concentration of Fe. However, following purification and delivery, the Fe level is moderate to low at times. The graph (In Figure-5) depicts such type of circumstances in general. Iron's WHO standard value is 1 mg/l. The iron value in the sample graph is high at sample 02. And it is 1.06 mg/l. In the majority of the samples, the iron content is zero.

3.12 Fecal Coliform

Fecal bacteria indicate the presence of sewage pollution in waterways as well as the potential presence of other harmful species. In our sample, we can observe that the house tap water is entirely contaminated with fecal coliform, which is a severe source of water pollution. That is undoubtedly a bad indication. That is an indicator of sewage pollution in the supply network, and the house tap water contains a high concentration of pathogens. The WHO standard value is 0mg/l (Rules, 1997). The greater value of fecal coliform in the graph (In Figure-5) is 22 CFU/100ml in tap ID 9. In terms of value, the majority of the sample value is lower.

Table 3: Water quality of different water sources.

Parameters	Max Value			Min Value			Standard Deviation		
	WASA water	Drinking Water	Tap Water	WASA water	Drinking Water	Tap Water	WASA water	Drinking Water	Tap Water
pH	8.32	8.52	8.54	6.4	6.76	6	0.58	0.55	0.68
DO	9.56	8.75	8.55	3.12	2.49	3.97	1.80	1.54	1.56
Color	61	43	32	0	0	0	17.54	14.05	8.46
Conductivity	499	494	602	262	0	0	65.49	104.71	132.06
TDS	241	196.2	261	121.3	120.5	126.5	43.23	34.77	49.18
TSS	12	5	5	0	0.49	0	3.24	1.55	1.23
Hardness	181	127	168	94	29	58	26.11	24.32	29.06
Cl^-	80.08	246.25	195.2	7	4.4	4.9	21.62	61.86	56.61
Turbidity	13.07	6.33	6.33	0	0	0	3.41	1.82	2.10
Alkalinity	106.17	125.2	91.14	54.86	53.08	50.58	11.87	18.99	11.98
Fe	1.06	1.06	0.33	0	0	0	0.33	0.26	0.12
Fecal Coliform	14	8	13	0	0	0	3.71	2.32	6.48
Temp.	26.6	27.2	26.9	19.5	19.5	19.4	2.10	2.05	2.05

Residential tap water conductivity varies. Both supply and WASA have high total dissolved and suspended solid values. They are, nevertheless, within a safe range. Some WASA samples are more difficult than others. Because disinfectants were used, the Cl value of the three sample locations is high. WASA turbidity in one sample is extremely high. We discovered that the WASA water samples had a high amount of iron. However, both supply and drinking water is rather restricted. We discovered that fecal coliforms are prevalent in household tap water. Other metrics that we looked at were within acceptable ranges.

3.13 Water quality index (WQI)

The water quality index (WQI) is a 100-point scale that summarizes results from different measurements when complete. WQI depends on the parameters that are tested and changes with the value of the parameters.

Brown method: In 1970, the National Sanitation Foundation created a Water Quality Index (WQI). The index reflects the combined effect of key physical and chemical factors. The index application provides a defined, intelligible unit of measure that responds to changes in water quality. The calculation of WQI was made by using the following equation (Lenhoff & Brown, 1970):

$$WQI = \frac{\sum Qiwi}{\sum wi} \tag{1}$$

The quality rating scale (*Qi*) for each parameter is calculated by using this expression:

$$Qi = 100\left[\frac{Vi-Vo}{Si-Vo}\right] \tag{2}$$

Where,
Vi is the estimated concentration of the i^{th} parameter in the analyzed water
Vo is the ideal value of this parameter in pure water
Vo = 0 (except pH =7.0 and DO = 14.6 mg/l)
Si is recommended standard value of the i^{th} parameter

The unit weight (*Wi*) for each water quality parameter is calculated by using the following formula:

$$Wi = \frac{K}{si} \tag{3}$$

Where,

K = proportionality constant and can also be calculated by using the following equation:

$$K = \frac{1}{\Sigma\left(\frac{1}{Si}\right)} \tag{4}$$

Table V shows the water quality rating according to this WQI.

Table 4: Water quality rating as per weight arithmetic water quality index method.

WQI Value	Rating of Water Quality
0-25	Excellent water quality
26-50	Good water quality
51-75	Poor water quality
76-100	Very Poor water quality
>100	Unsuitable for drinking water for supply after conventional treatment

When all measurements are completed, the water quality index (WQI) is a 100-point scale that summarizes the data. WQI is determined by the parameters that are tested. The value of WQI fluctuates as the parameters' values vary.

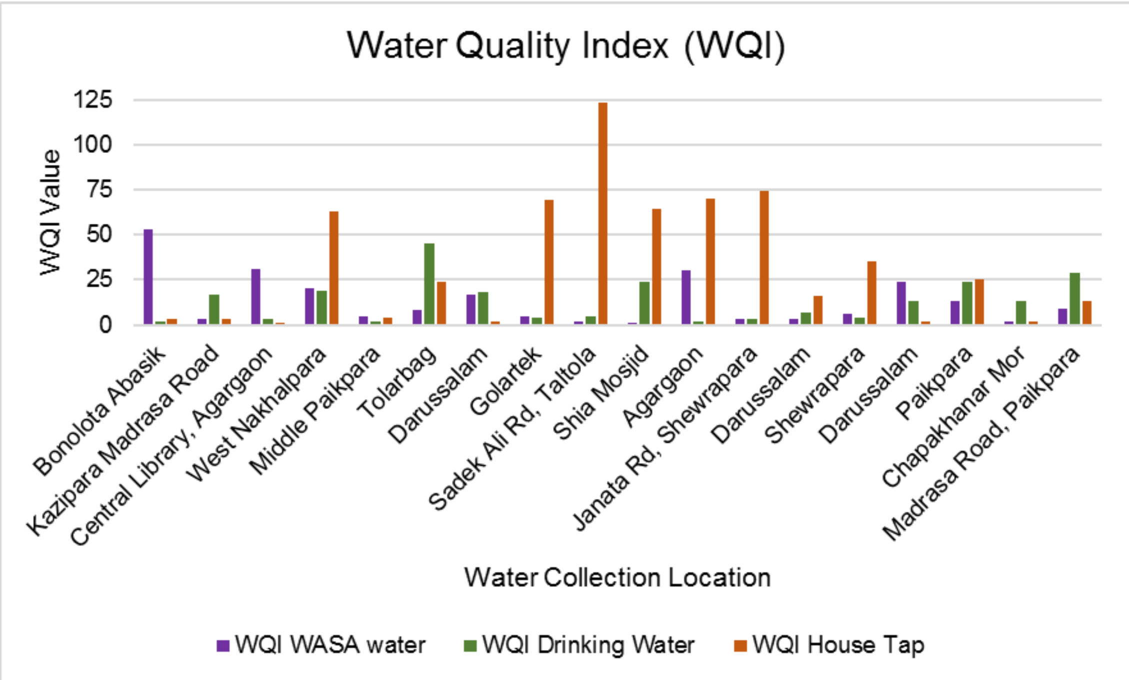

Figure 6: Water quality index and its range of WASA, Drinking Water and House Tap Water.

WQI and parameter values alter disproportionally. The value of sample 23 in the accompanying water index number table is in the poor range, whereas sample 01 is in the medium range. Other samples are in the good to outstanding category. The highest value on the graph is for drinking water in Tolarbag. However, it is within a reasonable range. Paikpara's Madrasa Road is also within walking distance. Other water in the region is great. Taltola's water is of very poor quality. West Nakhalpara, Golartek, Shia masjid, Agargaon, and Janata road Shewrapara samples are all in the middle range. Other samples from other places are either outstanding or good.

3.14 WASA water in pre-monsoon and monsoon periods

The quality of parameters of DWASA-supplied water mostly changes throughout the years. The parameters are found in different quantities in different seasons. The changes are shown graphically in

Figure 8. The value of pH is changing in the pre-monsoon period but is almost stable during the monsoon period. From the graph, it can be seen that the DO of the pre-monsoon period is unsteady. But it is steady during the monsoon period. In the premonsoon period the conductivity of water is not changing much without the highest peak sample no 4. The value of this pick is 499 µ/c. But in the monsoon period, a sudden degradation happens at sample 7 and then it shows consistency. At some point TDS value changes in the premonsoon period but it is more consistent afterward. But during the monsoon period TDS shows more inconsistency. In the monsoon period sample, 6 shows the lowest TDS which is 140mg/l but sample 7 shows the highest value 312mg/l. After that it is steady.

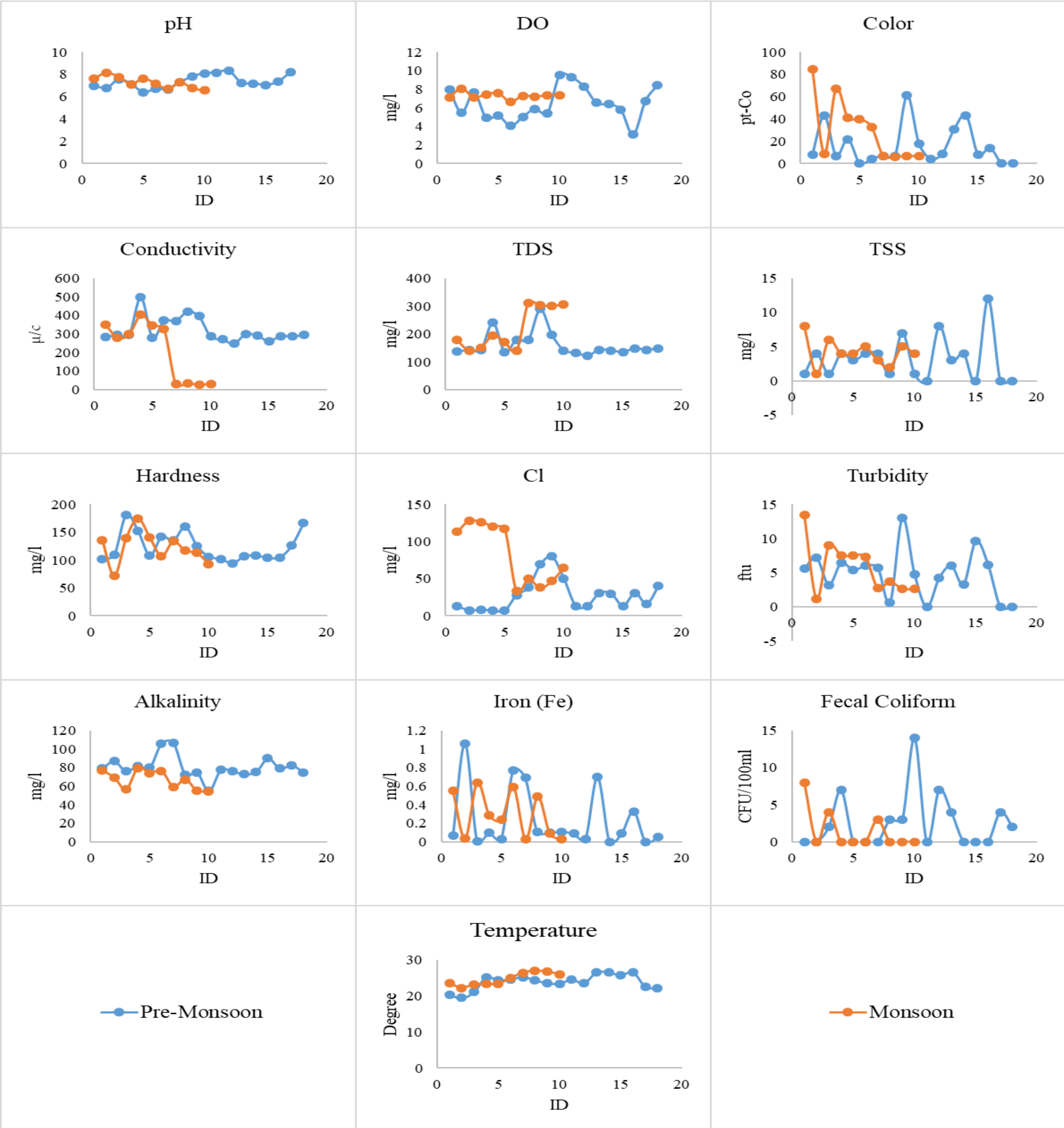

Figure 7: Variation of water quality parameters in monsoon and pre-monsoon seasons.

TSS shows ups and down values during both the pre-monsoon and monsoon periods. The highest value of TSS in the pre-monsoon period is 16 mg/l at sample id 12. And in the monsoon period, the highest value is 8 mg/l gin sample 1. During the monsoon and pre-monsoon periods, the value of hardness is changing rapidly. The highest value of hardness in the pre-monsoon period is 181 mg/l at sample no 3. In the monsoon period, the highest value of hardness is 175 mg/l at sample no 4. The highest value of chlorine in the pre-monsoon period is 80 mg/l at sample no 8. In the monsoon period, the highest value is 128 mg/l at sample no 2. All the values of both the monsoon and pre-monsoon periods are not stable. The highest value for the monsoon period is 13.42 ftu in sample 1 and the highest value for the pre-monsoon period is 13.07 ftu in sample 9. Overall, the values of alkalinity in the premonsoon and pre-monsoon period are stable. The highest value in the premonsoon period is 106 mg/l and 79. mg/l in the monsoon period. The value of iron is changing frequently throughout the whole premonsoon and monsoon period. The highest value in the premonsoon period is 1.06 mg/l at sample no 2. And the highest value during the monsoon period is 0.64 mg/l at sample no 3. Fecal coliform shows variation in both pre-monsoon and monsoon periods. The highest value is 14 CFU/100ml in sample no 10 in the pre-monsoon period. And the highest value in the monsoon period is 8 CFU/100ml in sample no 1. Temperature shows variation in both pre-monsoon and monsoon periods. It crosses 25ºC in monsoon and decreases to 19ºC in non-monsoon.

4. CONCLUSIONS

Households in Mirpur localities have not only had insufficient water delivery, but also a severe lack of domestic tap water during the pre-monsoon season. Water quality test results from 28 DWASA sites in the Mirpur region, as well as the DWASA distribution system. Drinking water is also tested for purity. The water quality test of the targeted sample revealed that the sample's water quality is sufficient. Though the observed values of pH, turbidity, alkalinity, hardness, BOD5, Total dissolved solids (TDS), Total suspended solids (TSS), and Fecal coliform were mainly within the acceptable range, several parameters in virtually all of the chosen samples were higher or lower. This difference does not represent a major change in water quality in the Mirpur region. The piped water supply systems used by DWASA are often buried in intricate reticulations and are challenging to run and maintain. Nonetheless, they are equally crucial in maintaining the availability of clean drinking water as water resources and treatment facilities. The water supply line for domestic usage should be of good quality, and the trash disposal should be a point of contention. To protect those facilities, continuous monitoring facilities should be installed in the distribution system. More data-gathering findings should help to fine-tune the process. Public knowledge can also play a significant role in preventing such issues.

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